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# Community Solar: A Pathway toward Leadership for Higher Education Institutions

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By

Kevin Moens

Accepted in Partial Completion
of the Requirements for the Degree
Master of Arts, Environmental Studies

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**Master's Field Project**

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

A Field Project
Presented to
The Faculty of
Western Washington University

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## Abstract

Higher education institutions equip their graduates with the skills and knowledge to become leaders and future problem-solvers. Increasingly, higher education institutions are seeking ways to lead in sustainability and ensure a legacy of progressive environmental change. One option for these institutions to enhance sustainability is to hosting community solar projects. Community Solar, defined by Northwest SEED, is a voluntary solar program providing power and/or financial benefits to, or is owned by, multiple community members. This research details two potential community solar models for higher education institutions: non-profit and for-profit. Through informal interviews with key informants, National Renewable Energy Laboratory technical assistance, undergraduate research and financial modeling the non-profit option is recommended. Using upfront payments from community solar participants, a Western Washington University Foundation partnership, federal tax incentives, value of energy produced and a university buyout, the non-profit community solar project is feasible to be hosted at Western Washington University. Being a community solar host provides higher education institutions with a means of decreasing community carbon emissions, increasing access to renewable energy, advancing institution-community relations, normalizing renewable energy for students, providing faculty and student research opportunities, and positioning these institutions as leaders in sustainability.

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Acronym List-

CS- Community Solar
ESS- Energy System Synthesis
GW- Gigawatt
HEI- Higher Education Institution
ITC- Investment Tax Credit
kW- Kilowatts
kWh- Kilowatt hours
LLC- Limited Liability Company
MACRS- Modified Accelerated Cost Recovery System
MW- Megawatts
MUB- Multiuse Building (Athletics Shed or Team House)
NREL- National Renewable Energy Laboratory
PSE- Puget Sound Energy
PV- Photovoltaic
SAM- System Advisory Modeling
SEC- Securities and Exchange Commission
SSA- Solar Service Agreement
UTC- Utilities and Trade Commission
WASPI- Washington State Production Incentive
WWU- Western Washington University

## 1 - Introduction

This report provides a recommendation to Western Washington University (WWU) for creating a campus hosted Community Solar (CS) project. The recommendation answers five research questions 1) What is the most appropriate ownership model? 2) What campus location is most suitable for solar energy siting? 3) What CS financing structure is most appropriate? 4) What are pertinent local, state, federal regulations? and 5) What are the benefits to WWU and the community? The recommendation paves the way for WWU to become a Higher Education Institution (HEI) leader in sustainability through actively engaging sustainability efforts internally at the university and externally with the community.

CS provides mutual benefits to WWU and to the community, defined as anyone within Puget Sound Energy's (PSE) service area, by spreading the financial costs and environmental and financial benefits of solar energy production to multiple parties. CS developed in response to financial and siting barriers which limit the accessibility of traditional single owner Photovoltaic (PV) arrays. CS aims to overcome these non-technical barriers to solar energy adoption through the distribution of costs and benefits to multiple members of a community. Additionally, the development of CS on an HEI campus will have many favorable effects.

HEIs are advantageously positioned to promote sustainability efforts through their role as educators and researchers in society. The organizational structure of HEIs also allows for the inclusion of an increasingly sustainability focused student body. HEI hosted CS will incorporate the research and application of sustainability into university practices. While also increasing local renewable energy production and accessibility of solar energy to the community.

Capitalizing on WWU's position as an HEI, this project is able to incorporate student research in conjunction with this graduate research project.

Throughout the research process a number of undergraduate students at WWU have participated in the research efforts. Through structured class-based coursework integrated into WWU's Institute for Energy Studies and through directed independent study work. Their efforts have been invaluable to this research and will be more fully discussed in the methods chapter.

The purpose of CS is to reduce the barriers to solar energy adoption by increasing accessibility to solar energy. HEIs are unique organizations within society and as such are favorably positioned to promote sustainability efforts internally and externally. WWU hosted CS will further integrate the practice of sustainability into university operations, education, and research, helping to position WWU as a leader in HEI sustainability efforts.

## 2 - Literature Review and Context

2.1- Literature Review

HEIs have two primary missions allowing them to help create an educated and responsible society while also perpetuating knowledge production and dissemination. HEI's dual primary missions are education and research (Trencher, 2014). These roles have traditionally been practiced through Newtonian and Cartesian paradigms (Nonaka & Takeuchi, 2001), which emphasize reductionist thinking and a mechanistic view of the natural world (Lozano, R., Lukman, R., Lozono, F., Huisingh, D., Lambrechts, W., 2013; Lozano, R., Lozano, F. J., Mulder, K., Huisingh, D., & Waas, T., 2013A). Following these roles HEIs have become responsible for producing an "educated and socially responsible work force" (Blackwell et al., 2012, 2), while also acting as places of "knowledge production, knowledge perpetuation and knowledge dissemination" (Stephens, J., Hernandez, M., Román, M., Grahm, A., & Scholz, R., 2008, 320) HEIs are also well known as disseminators of change, both technologically and socially (Stephens et al., 2008), but have also been considered microcosms of larger society (Cortese, 2003). There have been increasing calls for HEIs to shift from their traditional paradigms toward a paradigm of sustainable development (Lozano et al., 2013) as defined by the report *Our Common Future* (Brundtland, 1987).

HEIs are uniquely positioned to promote sustainability as educators, researchers, and disseminators of social and technological change. HEIs are ideal places for renewable energy efforts due to their capacity to engage faculty, students and employees around sustainability efforts (Blackwell et al., 2012; Thomashow, 2014). Being responsible for educating future leaders, decision-makers, and the general public, HEIs play an important role in contributing to a more sustainable future (Davies, S., Edmister, J., Sullivan, K. and West, C., 2003; Sherren, 2006). Additionally, HEIs have the opportunity to lead sustainability efforts through their unique position as educational institutions in society, increasingly environmentally focused student culture, and organizational structure (Thomashow, 2014). However, to become leaders in sustainability, HEIs need “their faculty, staff and students... to be engaged in cross-disciplinary efforts at all levels of the social system” (Lozano et al., 2013A, 4). Sustainability also needs to be the "Golden Thread" connecting an HEI's education, research, operations and external community relations, leading toward a sustainable development paradigm (Cortese, 2003). Furthermore, it is the responsibility, and potentially moral obligation, of HEIs to contribute to a more sustainable future (Cortese, 2003; Davies et al., 2003; Sherren, 2006). Though the higher education paradigm has not completely shifted toward sustainable development, HEIs have been working toward sustainability goals for over three decades.

HEIs have committed to sustainability through national and international agreements, governmental programs, and numerous campus-based projects. The first international HEI declaration for sustainability was the Talloires Declaration, signed in 1990 (Lozano et al., 2013). HEIs have also shown dedication to sustainability through membership in the Environmental Protection Agency's Green Power Partnership and signatories to the American Colleges and Universities Presidents' Climate Commitment. The Green Power Partnership is a voluntary program which encourages organizations to become more sustainable through greening their power supply. The first HEI Green Power Partnership member was Carnegie Mellon University, in 2001, which set a goal of receiving 100% of its electricity from renewable energy credits. Since this time, 150 HEIs have become members, with many institutions, including WWU, committing to 100% green power (Environmental Protection Agency, 2016). The American Colleges and Universities Presidents' Climate Commitment was created specifically for HEIs to become leaders in sustainability through committing to carbon reduction or climate resilience (ACUPCC, 2016). Currently, there are more than 600 HEIs, including WWU, in all 50 states who have signed one of the above climate leadership commitments (ACUPCC, 2016). These actions taken by HEI prove they can act as leaders as defined by Post as "the ability to see a problem and be the solution" (2017). Furthermore, HEIs have shown commitment and leadership to sustainability in a number of other ways, including creating offices of sustainability, producing renewable energy on site, developing revolving green funds, starting recycling initiatives, instituting food waste reduction programs, and supporting green transportation projects. Campus hosted CS is another avenue for HEIs to show leadership in sustainability, by supporting the development of more accessible and affordable renewable energy.

### 2.2- Community Solar

Solar PV has experienced significant growth over the last 10 years, however this growth has been inaccessible to most potential consumers. Between 2005 and 2014, PV installations grew by 7,800% from 79 MW annually to 6.2 GW annually (SEIA and GTM, 2015). This growth has been capitalized on by a small portion of potential consumers due to PV business models and regulatory structures (Feldman, D., Brockway, A., Ulrich, E., & Margolis, R., 2015). Furthermore, the National Renewable Energy Laboratory (NREL) estimates 49% of houses and 48% of businesses in the United States are unable to host solar PV due to a lack of ownership, space restrictions, or siting requirements (Feldman et al., 2015). Consideration of solar PV barriers including array siting restrictions (e.g., shading, roof space, roof condition), ownership (e.g., renters, multifamily homes), and access to capital, which limit potential development (Artale & Dobos, 2015; Asmus, 2008; Augustine & McGavisk, 2016; Feldman et al., 2015). These non-technical barriers leave at least half of the US unsuitable for development, while allowing the social, economic and environmental benefits of solar PV to be harnessed by consumers with ideal roof space in relation to energy consumption, independent decision-making ability, and access to financial capital (Feldman et al., 2015). These restrictions open the door for CS to reach otherwise inaccessible consumers and provide them with the opportunity for solar PV access.

CS increases access to solar PV through mitigating many non-technical barriers, while in turn, making the social, economic and environmental benefits of solar PV available to more consumers. CS is defined as “a solar-electric system that, through a voluntary program, provides power and/or financial benefit to, or is owned by, multiple community members” (Coughlin, J., Grove, J., Irvine, L., Jacobs, J., Phillips, S., Moynihan, L., Wiedman, J., 2010, 2). As a voluntary program, CS distributes the costs and benefits of a solar PV array to multiple parties. Through locating the array offsite from end consumers and allowing individuals to subscribe to, or lease portions of the array, through an administrative organization, economies of scale can be reached as well as eliminating individual solar PV siting requirements (Feldman et al., 2015). Furthermore, CS may financially help individual subscribers through buffering against rising electricity costs. CS can also help communities through “lower criteria pollutant emissions (leading to improved public health), lower greenhouse gas emissions, economic development/local jobs, reduced water consumption, and reduced dependence on fossil fuels” (Augustine and McGavisk, 2016, 37). Additionally, CS increases community awareness, provides opportunities for entrepreneurs, and new models of solar development (Coughlin et al., 2010; Feldman et al., 2015). CS has many potential benefits; however, to realize them, it is important to understand the different ownership models.

### *2.2.1- Community Solar Ownership Models*

There are three principal ownership models for CS: utility owned, special purpose entity, and non-profit. Individual CS programs are often developed to meet specific community and consumer needs. These broad model types are meant to describe potential CS programs and not to specifically define all ownership models.

Utility owned CS is a common ownership type where a local electric utility constructs, owns and operates the CS project. In this model, consumers subscribe to a portion of a CS array and received credit on the utility bill for the energy produced. Subscribers may lease their portion of the CS array or provide an upfront payment for the life of the project. Utilities often have the financial capital and administrative capabilities to manage a CS program successfully. Utilities also have a large customer base fulling the main goal of CS, to increase access to solar PV energy. Furthermore, investor owned utilities (i.e. privately-owned utilities), generally have a significant tax appetite allowing them to take advantage of federal tax incentives (Coughlin et al., 2010). Additionally, utility owned CS allows for the utility to lower the costs of renewables and strategically integrate them into the grid. CS also allows the utility an opportunity to show their support for renewables to their local community (Feldman et al., 2015).

A second ownership model is a special purpose entity. A special purpose entity can be any one of several business models, including General Partnerships, Limited Partnerships, Limited Liability Companies, Cooperatives, For-Profit Corporations, and Non-Profit Corporations (Coughlin et al., 2010). Though all special purpose entity models are potentially suitable for CS development, Limited Liability Companies (LLCs) are the most common and will be more thoroughly discussed.

In LLC CS ownership, the LLC leases space from a third party to site the solar PV array. The energy associated with the array's production is sold to the host site or to the local utility. Any federal tax benefits or state production incentives would be passed through to the LLC members. The LLC is also be responsible for insuring and maintaining the array. LLCs are private companies formed by community members (individuals or businesses) with limited liability as the individual members are not responsible for the LLC's debt. Furthermore, LLCs have the advantage of being taxed only once on their profits at individual members tax rates through the cash accounting method. The LLC can also help take advantage of federal benefits such as the Investor Tax Credit (ITC). These benefits can significantly reduce the payback period for CS and create a more financially feasible project. However, there are numerous concerns, such as Security Exchange Commission (SEC) regulations and individual tax appetite, which need to be addressed in order for an LLC CS ownership model to be effectively used (Coughlin et al., 2010).

The third CS ownership model is non-profit. A non-profit CS ownership model allows for a local non-profit organization to own the solar PV array and receive the energy and financial benefits.

The CS project is funded through donations from individuals and organizations or from public or private grants. The solar PV array is generally sited on the non-profit’s building or property. There are limited benefits to donors in the non-profit CS model outside of a tax write off for the donations (Coughlin et al., 2010).

*2.2.2- Solar Array Siting*

Solar PV array siting is critical to the amount of energy produced as well as the installation costs. These two factors weigh heavily on the financial feasibility of a CS project. Energy produced from the array is the primary source of cost recovery and is the main benefit of the array. Specific factors to be considered for siting include: ground mounting or roof mounting, roof orientation, roof condition and roof shading (Seattle City Light, 2009; WSU Extension Energy Program, 2009).

Factors specific to CS siting on HEI property include building age, roof age, inverter space, campus electricity tie-in, image and visibility. HEI's will use arrays beyond energy production, resulting in the need for further consideration of siting locations including accessibility for the array and the array’s production data for educational and research opportunities. How the array will be perceived, used, and benefits to the HEI, student body and surrounding community are also valuable considerations. HEI campuses are also in a continual state of change with new buildings and redevelopments, requiring a consideration of the campus master plans and future projects. Overall, the siting of the array needs to allow and even encourage research, education, financial viability, and promote the campus as environmentally conscious.

Solar PV siting on WWU's campus closely follows the general HEI considerations previously outlined, including determining the most energy productive locations, roof age, roof building material and condition, inverter space, campus electricity tie-in, image and visibility. Special consideration of accessibility and visibility was taken to ensure the array would be visible to students and community members and allow the possibility of student research on the array. A notable consideration also went into the building roof structure as some roof materials are more expensive to build on than others.

## 2.3- Context

In this section, federal tax and state production incentive policies are reviewed with respect to CS projects.

### *2.3.1- Federal Policy*

First enacted in 2005 and extended in 2006, 2008 and 2015, the Investment Tax Credit (ITC) provides a 30% tax credit on commercial (section 48) and residential (section 25D) solar energy systems (SEIA Solar Investment Tax Credit, 2017). The residential (section 25D) ITC is usually used by persons installing the solar equipment on their houses or property, however, the tax credit may sometimes be used by persons in CS projects. The ITC does not specify the solar array must be connected to the tax payer's residence, allowing a narrow gap for community solar interested tax payers to also tax advantage of the ITC. In order to be available, the energy produced must be used to power the residence of the tax applicant (CS participant), and the amount of energy generated must be similar to the amount of energy consumed by the residence of the taxpayer (CS participant). The energy produced from the array must also be owned by the taxpayer (IRS Notice 2013-70, 2013). Due to this, if the array is located off site from the residence of the CS participant but the power generated is meant to offset the residences' energy use and is owned by the taxpayer, the ITC may be available. However, if the ITC is available, the tax credit is only applicable to passive income as the credit was gained through a passive enterprise (IRS Publication 925, 2016).

The section 48 commercial ITC allows for-profit entities such as businesses to also receive the 30% tax credit (Feldman et al., 2015). This credit allows for the direct dollar for dollar reduction in taxes for the investor. The section 48 commercial ITC is different from the section 25D ITC. The commercial section 48 allows for the entity which installs, develops or finances the array to receive the tax credit (SEIA Solar Investment Tax Credit, 2017).

Modified Accelerated Cost Recovery System (MACRS) is a federal tax policy allowing businesses to depreciate solar energy property. Depreciation refers to the loss in value of property over time and will need to be replaced (Coughlin et al., 2010). MACRS allows solar energy developers to receive a tax deduction of up to 85% of the costs of the system over five years (SEIA Depreciation of Solar Energy Property in MACRS 2017). However, this depreciation value is not directly available as a general tax deduction and is only applicable to passive income as the depreciation was gained from a passive loss (IRS Publication 925, 2016).

Evidence for the availability of the ITC for CS projects can be seen in the IRS Public Ruling Letter (PRL) 111860-15 (2015) where an individual, who was a member of an LLC, built a solar array off site. Members of the LLC are each partial owners of the array and the energy produced is net metered with the local utility. The amount of energy produced by the panels owned by the individual is not large enough to offset the amount of energy consumed by the tax payer's residence. The IRS ruled based on the individual facts, the taxpayer is able to receive the ITC. While PRL's are legally restricted from acting as precedent or as evidence, the IRS is able to reference them internally as guidelines.

CS projects are at risk of being considered securities by the Securities and Exchange Commission (SEC) and thus subject to SEC regulations for reporting and compliance. The purpose of the SEC is to help protect public investors from enterprises which may be fraudulent (Feldman et al., 2015). CS projects are at risk because any organization which raises capital through the "offering or selling of stock, membership units, partnership interests or other types of participation interests" may be considered a security (Coughlin et al., 2010, 32). CS projects often sell or provide memberships to subscribers, creating a risk that these projects will fall under the definition of a security and be subsequently subject to regulation. These regulations can be very costly and time consuming for CS projects. However, CS developers can use an "Investment Contract Test" to help determine if their project will fall under federal regulation. The test has four questions- Does a person invest money or property? Is it a common enterprise? Is this profit based on the efforts of someone else other than the person contributing money or property? Is there an expectation of profit? (Coughlin et al., 2010). The critical question for CS is the expectation of profit. Depending on how the CS project is organized and the way the project is advertised to potential subscribers, the answer to this question may not be yes, if the CS project organizers refrained from claiming any monetary benefits for subscribers. However, CS organizers can also petition for a private placement exemption with the SEC (Coughlin et al., 2010). A private placement exemption allows for the organization to be free from SEC registration (SEC Investor Bulletin, 2017). Federal regulations can be incredibly helpful to CS through tax incentives as well as detrimental regarding securities regulations, but state CS policies can be even more influential.

### *2.3.2- State Policy*

Passed on July 1, 2017, by the Washington State Legislature, Engrossed Substitute Senate Bill 5939, referred to here as Washington State Production Incentive (WASPI) creates a new renewable energy production incentive replacing the state's existing Renewable Energy System Cost Recovery policy. The purpose of WASPI is to promote "a sustainable, local renewable energy industry through modifying renewable energy system tax incentives and providing guidance for renewable energy system component recycling" (RCW 82.16.165). The updated WASPI policy provides a per kWh production incentive to qualifying renewable energy technologies, including solar PV, community solar PV, anaerobic digesters and wind turbines. These qualifying renewable energy systems need to be certified with the Washington State University Energy Extension program. Starting in 2018, the WASPI policy provides a $0.16 kWh incentive for community solar and an additional $0.05 incentive if the renewable energy system was manufactured in Washington state. The community solar incentive decreases by $0.02 per year and the made in Washington incentive decreases by $0.01 per year. The WASPI policy is set to end in 2021 as the renewable energy industry in Washington is assumed to be self-sustaining by this time (RCW 82.16.165).

Net Energy Metering (NEM) is a policy mechanism meant to value surplus energy created by electric utility customers who generate energy from renewables. The energy generated is marked against their consumption of utility provided energy. To be eligible for net metering the energy must be generated from a "water, wind, solar energy, or biogas from animal waste as a fuel, fuel cells or heat to power systems" (RCW 80.60.010 (14)) and are at or under 100 kW in size. Utilities are required to accept these approved renewable energy resources on a first come first served basis, up to 0.5% of their utility's peak generating capacity in 1996 (RCW 80.60).

### 2.4- Case Study

Western Washington University is located in Bellingham, WA, in northwestern Washington state. Bellingham is a community of 83,000 with WWU as the second largest employer at 1,072 employees (COB Comprehensive Financial Planning Report, 2013). WWU is a HEI with a history of environmental and sustainability action. WWU founded Huxley College of the Environment in 1970 and was one of the first environment colleges in the US (Dietrich, 2011). Today, WWU incorporates numerous sustainability efforts such as Sustainable Communities Partnership, which combines local municipalities' sustainability needs with WWU's expertise, academic programs, and research capabilities. WWU is currently developing its first Sustainable Action Plan with the purpose of promoting sustainability throughout the university. WWU also has numerous sustainability programs promoting energy efficiency, recycling, food waste, sustainable transportation and is a signatory to the American College and University Presidents Climate Commitment. Furthermore, WWU is committed to obtaining 100% of its electricity from renewable resources and has recently joined Puget Sound Energy's Green Direct program to directly procure wind energy (Western Sustainability, 2017).

WWU has two existing solar PV energy projects on campus. The first project is sited on the roof of WWU's Student Union building. The 2 kW array is meant more as an educational demonstration of solar PV energy production than as a significant source of energy. Constructed in 2008, the project took 2.5 years to complete with an estimated cost of $68,000 at $25.50/watt. This pricing is nearly three times the average cost of solar PV installations in 2007 and was most likely due to the small system size and prevailing wages. The project was funded through grants from a mix of organizations including Puget Sound Energy (PSE), Western Washington University Foundation (WWUF), Alpha Energy, Bonneville Environmental Foundation, and WWU Facilities Management. The project was led by the WWU's Students for Renewable Energy club and experienced significant support (Lynch and Tsitsiragos, 2017).

The second solar PV project at WWU was completed in 2012 and is sited on the Environmental Studies building's roof. This array is more extensive than the Student Union project at 5.6 kW and had a goal of increasing campus-based energy production. The project was funded through WWU's Sustainable Action Fund with an overall cost of $152,000 at $27/watt. The significant costs per watt for this project are due to the unique aluminum frame required for siting on the Environmental Studies building, engineering costs and a change order totaling close to $100,000. Furthermore, a lack of communication with the installer during the planning stages led to exaggerated costs and should be considered a lesson for future projects (Lynch and Tsitsiragos 2017).

In 2017, WWU signed an agreement to participate in Puget Sound Energy's Green Direct program. Green Direct is a green energy tariff program allowing large organizations, such as the King County government or WWU, to subscribe to a portion of a large scale renewable energy project. The subscription is long-term and provides a prearranged energy price for participating institutions. Green Direct allows large organizations, who do not want to use their own capital investments toward renewables, a means to access large amounts of renewable energy (Pyper, 2017). WWU will receive 100% renewable energy through the Green Direct program for the next 20 years starting in 2019.

Located in the northwest corner of Washington state, the city of Bellingham, home of WWU, is also committed to sustainability. Evidence of this commitment can be found in the city's creation and implementation of a climate action plan, accelerated solar PV permitting process, and water efficiency rebates. The city has been recognized as a Northwest Solar Community by Washington's governor (City of Bellingham, N.D.). Bellingham is also a finalist in the Georgetown University Energy Prize. The competition awards the city with the largest energy efficiency savings a $5 million prize (Bellingham Energy Prize, 2017).

## 3 - Methods

Due to the novelty of CS, available literature is minimal in both academic journals and white paper reports, thus limiting the availability of detailed CS information relevant to CS project development. To mitigate the lack of literature, a combination of informal interviews and surveys were conducted with key informants.

Key informants are defined by Payne and Payne (2004) as those with "special knowledge about other people, processes or happenings that is more extensive, detailed or privileged than ordinary people" and are, therefore "valuable sources of information to a researcher" (134). The key informants are identified through word of mouth referrals or are professionals or have significant experience in specific, relevant content areas.

The purpose of the informal interviews and surveys were twofold. One, the informal interviews were conducted to combat the lack of literature by speaking with key informants who have some level of knowledge about CS. The interviews also provided specific and detailed information that was unavailable in the existing literature. The informal interviews provide an opportunity for oversight and feedback on the CS project's progress from people with more knowledge or experience. Two, the purpose of the survey was to systematically record and categorize where information used to guide the project came from, as well as what the knowledge bases of the individuals who contributed. The results of the surveys were recorded in a survey matrix.

The survey matrix has four overarching categories: Solar Industry, CS, Community, and HEIs. Each category is divided into more specific subcategories (Figure 1), totaling eleven individual subcategories. Those surveyed responded to each subcategory with four potential responses: Experience, Knowledge, Input and Not Applicable. These answers are not explicitly defined, allowing for the individual responding to determine their own level of expertise in each subcategory. However, some general guidelines were provided for the potential answers.

Experience was defined as the responder has direct experience and a high level of confidence in a subcategory. The next potential answer was Knowledge, a step down in expertise from Experience, where the responder may still have a high level of confidence but may not have direct experience in a subcategory. The third potential answer was another step down in expertise where the responder has a lower level of confidence in a subcategory but may be able to provide direction toward literature or other individuals to interview. The final potential response is Not Applicable, where the responder does not have any salient information on the given subcategory.

| | Solar Industry | | | | Community Solar | | | | Community | | Higher Education Institutions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Array Siting | System Design | Incentives | Utility Coordination | Financing | Regulations | Marketing | Ownership Models | Outreach | Stakeholders | Facilities | Administration | Academics | Student Body |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Example- Kevin Moens, Graduate Student | E | K | K | I | K | K | I | K | I | K | K | K | E | E |

| | |
|---|---|
| Experience | E |
| Knowldege | K |
| Input | I |
| Not Applicable | N/A |

Figure 1 - Key Informants Survey Matrix, Template used during informal interviews with key informants.

### 3.1- Model Building

To better understand and quantify the feasibility of CS, a series of financial models were created. These models were based on information gained through informal interviews, literature, student research, NREL technical assistance results and a site assessment of the most suitable location for the array. The site assessment is critical to the finical modeling of CS as it provides the initial cost estimate for installing the array. A second piece of critical information for the financial models was the estimated future value of the solar PV array. This information was gained through the use of PVValue.com. The website allows for the input of several variables including, energy pricing and escalation, system size, number of inverters, ownership, age and discount rates. From these variables, PVvalue creates a report estimating the value of the array over time. As new information became available or CS ownership models were researched, the models were updated in an iterative process. These models were also shown to solar industry professionals and key WWU stakeholders, who provided professional insights and direction. The models also helped to direct future research based on their financial feasibility or unfeasibility.

### 3.2- Undergraduate Research

During the spring quarter of 2017, Dr. Joel Swisher led a WWU Institute for Energy Studies capstone course titled Energy Systems Synthesis (ESS) with the project author, Kevin Moens, as the teaching assistant. The course incorporated the CS research of this project, allowing the students to apply their skills, while also working to improve the CS recommendation. During the fall quarter of 2017, two students from the ESS course carried on their CS research through an independent study course with Dr. Joel Swisher. The students provided a report on past solar PV projects at WWU, case studies from other HEIs, a survey of WWU students and faculty for on campus energy projects, and a review of potential solar legacy effects for WWU.

### 3.3- National Renewable Energy Laboratory

During the ESS course, the students applied for and received a National Renewable Energy Laboratory (NREL) technical assistance grant, which provided up to 20 hours of technical assistance from NREL. A process of conference calls, emails, and PowerPoint presentations were used to communicate student research goals and NREL technical assistance results. NREL drew upon several specialized solar PV energy software to provide their results including System Advisory Modeling (SAM) and Aurora.

## 4 - Results

The multiple research inquiries into CS have created many results: the survey matrix, undergraduate student findings (ESS Course, Independent Study), NREL technical assistance, and the CS financial models (Non-Profit Models 1 and 2, and For-Profit Models 1 and 2).

### 4.1 Survey Matrix Results

Thirteen key informants participated in the survey matrix with a total of 182 individual responses. These responses were recorded as levels of subcategory comprehension ranging from the lowest level (Not Applicable) and increasing to Input, Knowledge, and Experience. These answers were converted into numerical values where Not Applicable = 0, Input = 1, Knowledge = 2 and Experience = 3 (Figure 2).

| | Solar Industry | | | | Community Solar | | | | Community Members | | Higher Education Institutions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Array Siting | System Design | Incentives | Utility Coordination | Financing | Regulations | Marketing | Ownership Models | Outreach | Stakeholders | Facilities | Administration | Academics | Student Body |
| Solar Array Designer | 3 | 3 | 3 | 3 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 |
| Facilities Project Manager | 3 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 3 |
| Community Solar Developer | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 3 |
| Sustainability Officer | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| Solar Project Manager | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| Assistant Professor | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 1 | 2 | 3 |
| Director of Solar Development | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Director of Solar Sales | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 1 | 2 |
| Campus Energy Manager | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| Solar Project Manager | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 1 | 1 | 3 | 3 |
| SAF Program Advisor | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 |
| Director , Institute of Energy Studies | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Senior Director and Chief Operating Officer | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |

Figure 2- Results of surveys with key informants, individual survey respondent's results converted to numerical values. The key informant's names have been withheld from publication though their professional titles are listed.

The results show the survey matrix respondents are more knowledgeable in the overarching categories of Community and Higher Education Institutions. These overarching categories have average individual respondent scores of 2.64 for Community and 2.50 for Higher Education Institutions. The overarching category of Community Solar scored lowest with an average of 1.27 (Figure 3).

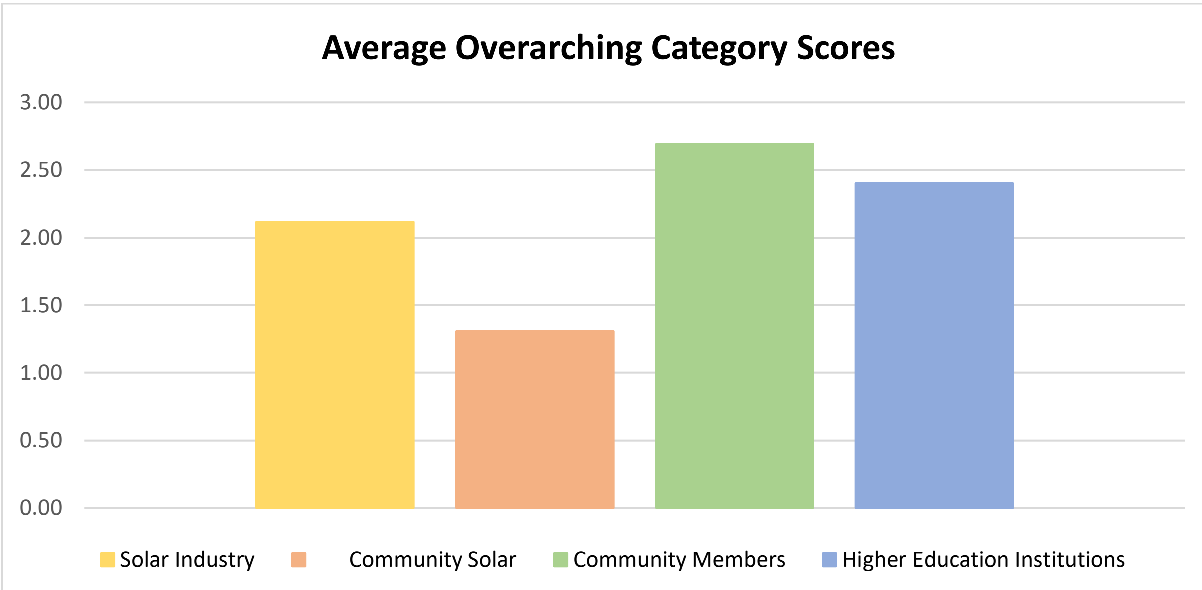


Figure 3- Results of the survey with key informants by overarching category.

Within the survey matrix's subcategories, Marketing scored lowest at an average of 1, while Student Body scored highest at 2.92. The subcategories of Outreach and Stakeholders were a close second at 2.69 each (Figure 4). The frequency of responses from the survey matrix are also insightful as the highest potential score of 3 (Experience) has over twice the frequency of the second highest score of 2 (Knowledge) (Figure 5).

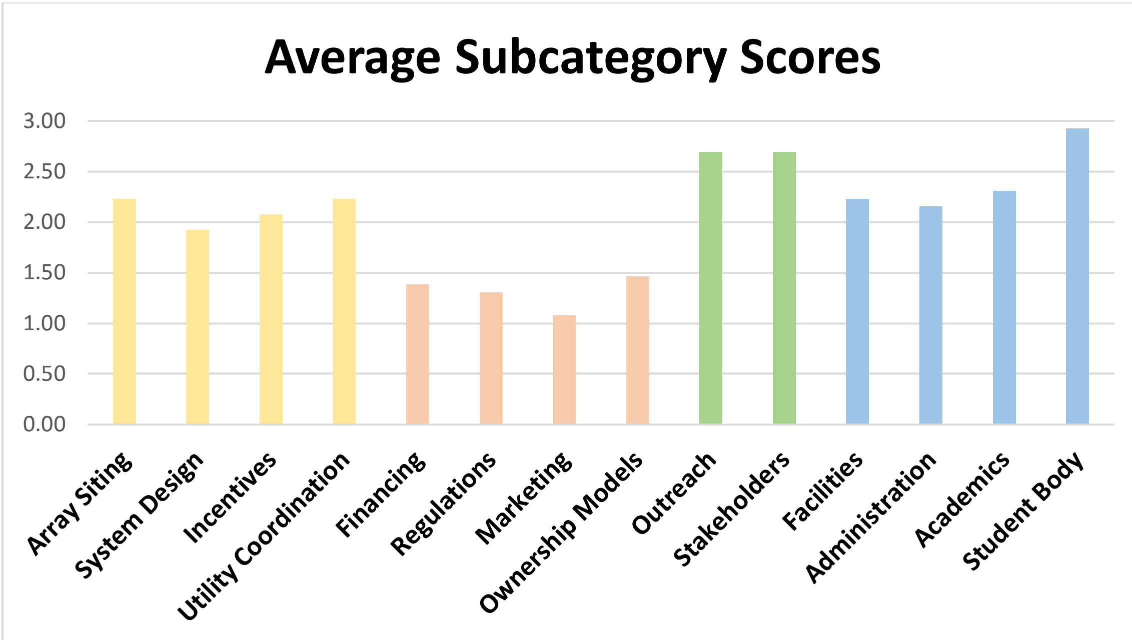


Figure 4- Results of the survey with key informants by subcategory. The yellow bars indicate results from the overarching category of Solar Industry, orange for Community Solar, green for Community and blue for Higher Education Institutions.

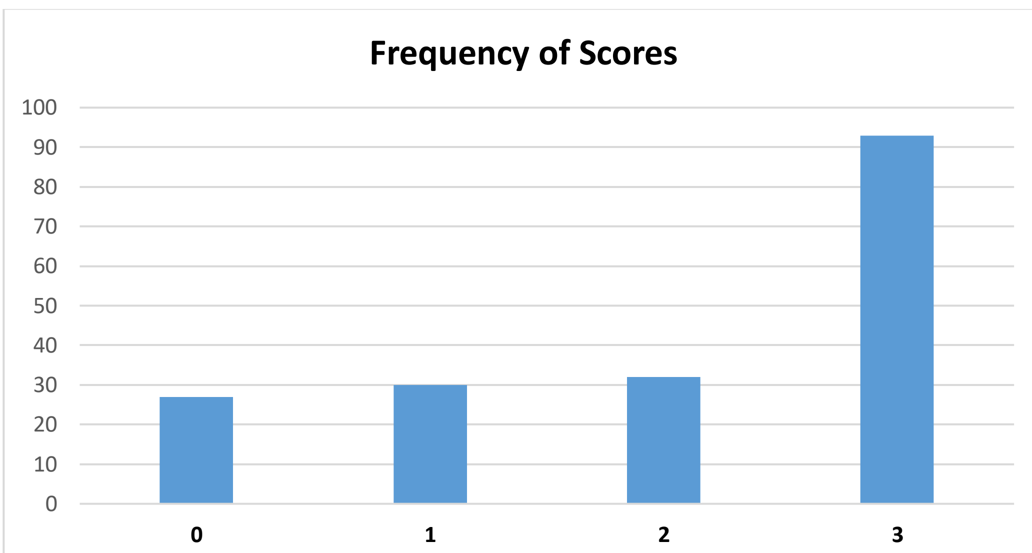


Figure 5- Results of key informants survey frequency scores. The bar labels equate to the level of comprehension provided by the key informants and converted to numerical values where 3 = Experience, 2 = Knowledge, 1 = Input and 0 = Not Applicable.

## 4.2- Energy Systems Synthesis (ESS) Course

Completed in the spring quarter of 2017, the ESS course consisted of six undergraduate students. These students researched the potential of creating a CS project at WWU. The course resulted in a seven chapter report "Community Solar on Campus: A Guide to Solar at Western Washington University with Community Investment" (Harp, G., Kemper, A., Lynch, K., Muir, N., Nevler, A., and Tsitsiragos, S., 2017) (See Appendix A). Though the entire report is important to furthering the research of CS at WWU, two critical ideas came from the class. The first is siting of the proposed CS array on the Multiuse Building (MUB), this building is known by other names including athletics shed and team house. This location was determined through a consideration of several ideal characteristics such as solar resource, visibility, accessibility, metal roofing, and ease of installation. Based on these considerations, six potential sites were initially examined: the MUB, South Parking Lot Hill, Grass East Triangle, Grass Triangle, Parks Hall, and Viking Union (see Appendix B). Part of the investigation included collecting solar resource data from these locations using a Solar Pathfinder tool (Figure 6). All six sites had >90% solar access, the largest being Parks Hall at 97.4% and the lowest being Grass Triangle at 91.85%. However, each site had additional characteristics which made them more or less suitable.[1] The report's final recommendation was the MUB for the proposed CS array due to its solar resource, visibility, standing seam metal roof, and ease of campus electricity grid tie in (Harp et al., 2017). The second critical idea developed from the ESS course was the inclusion of the WWUF as a partner in the CS project. The ESS report found the Western Washington University Foundation (WWUF) to be a logical partner for CS as the project would help meet the WWUF's mission. Furthermore, the ESS course saw the potential of developing a "renewable energy scholarship"

[1] Appendix A, (Harp et al., 2017, 30) Solar Pathfinder Results of Assessed Sites at WWU

from the value of the energy produced from the proposed array (Harp et al., 2017, 9). The role of the WWUF in this project has changed since its first conceptualization in the ESS course though the WWUF is still seen as a vital partner in the CS project.

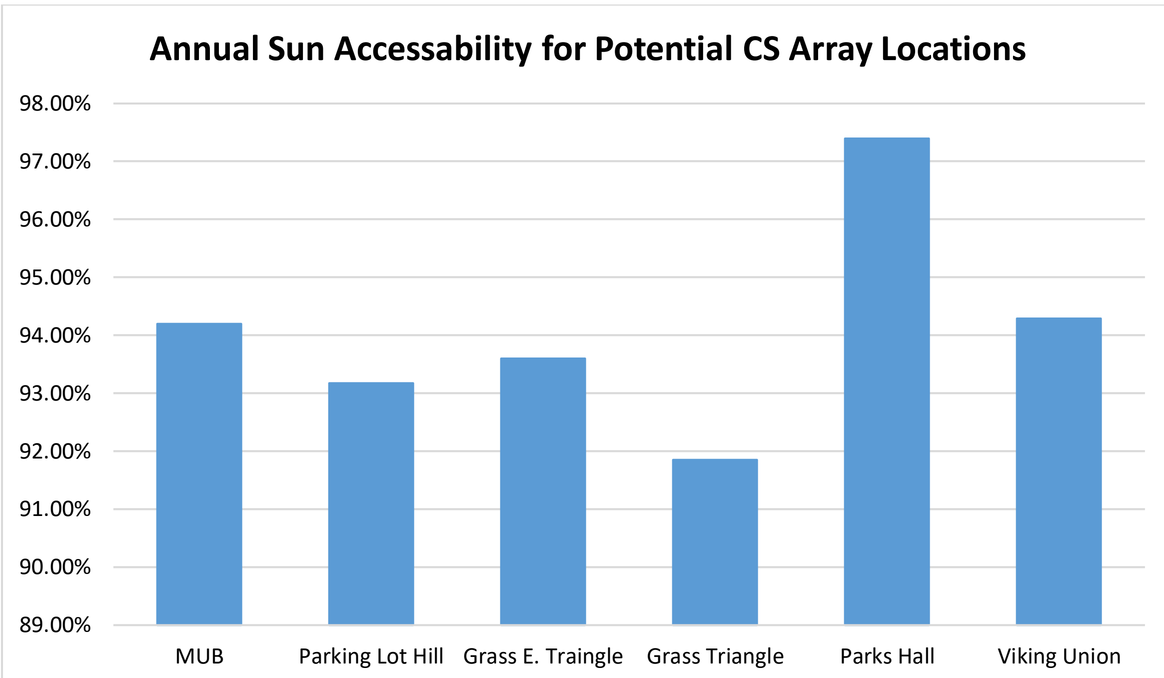


Figure 6- Results of Solar Pathfinder WWU potential solar PV site data collection

4.3- National Renewable Energy Laboratory

During the ESS course, the class applied for a NREL technical assistance grant. The grant was awarded, which gave WWU 40 hours of free technical assistance from NREL professionals. The technical assistance grant began in May 2017 and ended in early October 2017. NREL provided a final PowerPoint of all results at the end of the grant period (see Appendix C). The ESS course provided three potential solar sites and two ownership models (a WWU owned model and a for-profit community solar model). The three potential solar array sites considered were the MUB, Parks Hall and the Technology Development Center (located off campus). Only the MUB was considered for CS development while both the MUB and Parks Hall were considered for WWU as the single owner. The Technology Development Center was not thoroughly considered for CS or as a purchase option, most likely due to the impractical size (at 2.9 MW). The NREL analysis was conducted with Aurora Solar software, and the estimates of shading were based on an analysis using Google Earth, Google Street view and Bing Birds Eye (Dean, J., Kiatreungwattana, K., Hollander, A., 2017). No consideration of rooftop age, conditions and structural integrity were considered.

The technical assistance started with several base policy and financing assumptions (Table 1). The solar PV array design assumptions were based on a 10-degree tilt, 290 Watt SI modules, with a 17.3% efficiency, and a minimum solar access value of 90%. From these assumptions, NREL provided an estimation for purchasing arrays for both the MUB and Parks Hall (Table 2) (Dean et al., 2017).

Table 1- NREL Base Assumptions for Technical Assistance Analysis

| | Assumption |
|---|---|
| **Technologies** | Solar PV |
| **Ownership model** | Direct purchase and third party (PPA) |
| **Analysis period** | 20 years |
| **Discount rate** | 3% college/6% developer, real<br>5.06% college/8.12% developer, nominal |
| **O&M inflation rate** | 2% |
| **Utility escalation rate** | 0.93% real based on rates provided |
| **Tax incentives for developer** | PV: 30% ITC; 5 year MACRS |
| **SREC payment** | 11 cents/kWh per year for 8 years |
| **Net metering limit** | 100 kW |
| **Electricity sellback over net metering limit** | $0/kWh |
| **Interconnection limit** | 20 MW |
| **PV total installed costs** | $2.90/Watt-DC or $3.45/Watt-DC w/ WA PV panel and inverter |
| **Technology resource** | TMY3 |
| **Blended Utility Electric Rate** | $0.0959/kWh |

(Dean et al., 2017 10)

Table 2- Results of NREL Analysis for WWU Purchasing

| Scenario | Athletics Shed | Parks Hall | Total |
|---|---|---|---|
| System size (kW) | 71 | 75.4 | 146.4 |
| Net capital cost ($) | $202,178 | $214,814 | $416,992 |
| Annual energy (kWh/yr) | 72,258 | 77,211 | 149,469 |
| Capacity factor (year 1) | 11.8% | 11.8% | 11.8% |
| Energy yield (year 1) | 1,036 kWh/kW | 1,036 kWh/kW | 1,036 kWh/kW |
| Levelized COE (nominal) | 20.32 ¢/kWh | 20.17 ¢/kWh | 20.25 ¢/kWh |
| Net electricity savings with system (year 1) | $6,929 | $7,404 | $14,333 |
| Net demand savings with system (year 1) | $0 | $0 | $0 |
| Net present value ($) | ($86,187) | ($90,731) | ($176,918) |
| Payback period (yrs) | 26.7 | 26.4 | 26.55 |

(Dean et al., 2017 18).

The NREL technical assistance grant also provided the opportunity to research the potential for CS at WWU. At the bequest of the ESS course, NREL only considered the MUB for CS development. The analysis of CS was based on several key assumptions: 75 kW capacity, roof mounted, panel leasing, 15 panels per subscriber at a monthly panel lease price of $2.75/panel/month for a 25-year system life, 6% developer discount rate, $2.90 for Washington-produced panels and inverter, $2.25 for non-WA, estimated $20/kW/yr for operations and maintenance, and a utility rate of $0.0959/kWh. The WASPI policy was included at $0.21 kWh and federal tax incentives such as the ITC and MACRs were also considered (see Appendix C). Based on these inputs, NREL determined that CS was feasible (Tables 3 and 4) (Dean et al., 2017).

Table 3- NREL Community Solar Results Base Input Output

| Input/Output Summary | |
|---|---|
| System Owner IRR: | 11.5% |
| Panel Purchase Price: | N/A |
| Monthly Panel Lease Price: | $1.75 |

(Dean et al., 2017 23).

Table 4- NREL Community Solar Key Performance Indicators

| Key Performace Indicator | | System Owner | Subscriber |
|---|---|---|---|
| 25-Year Costs: | $ | ($385,802) | ($7,875.00) |
| 25-Year Revenues: | $ | $452,593 | $8,456.13 |
| 25-Year Net Benefits: | $ | $66,792 | $581.13 |
| 25-Year Net Present Value (NPV): | $ | $14,604 | $12.03 |
| Return on Investment (ROI): | % | 17.3% | 7% |
| Year 1 Bill Savings: | $ | N/A | $282.40 |
| Payback Period: | years | 3.8 | 15.6 |

(Dean et al., 2017 23).

## 4.4- Independent Study

Independent study coursework was conducted by Dr. Joel Swisher with students Kellen Lynch and Stella Tsitsiragos in the fall of 2017, resulting in a three-chapter report title "Community Solar Research Study" (Lynch and Tsitsiragos, 2017).

Chapter one of the report outlines past solar projects at WWU. The oldest project is a 2 kW array on the Viking Union building. Constructed in 2008, at a cost of $68,000, the array is meant to be an educational demonstration of solar PV technology. Funded through a mix of organizations including PSE, WWUF, Alpha Energy, Bonneville Environmental Foundation, and WWU Facilities management and was led by WWU's Students for Renewable Energy club (Lynch and Tsitsiragos, 2017). The second solar PV array on WWU's campus is located on the Environmental Studies building. Constructed in 2012, the 5.6 kW array costed $152,000. This project was funded through WWU's Sustainable Action Fund grant. The project encountered serious cost overruns due to a lack of planning and consultation with solar professionals. Both projects are quite expensive at $25.50/watt and $27/watt (Lynch and Tsitsiragos, 2017). For comparison, current installation prices are about $3.00/watt. However, the high project costs for solar at WWU can also be partially due to the small array sizes and the prevailing wages needed for construction on state property. Chapter one continues on to detail case studies of four other universities and their solar projects.

Chapter Two of the independent study report details a campus-based survey on the “awareness and support of energy projects on campus” (Lynch and Tsitsiragos, 2017, 18). The survey consisted of five questions and was conducted at multiple times and locations across WWU’s campus. The researchers surveyed 203 people, of which 186 respondents were students, 11 were employees, and 6 were classified as other. Of the respondents, 199 were in support of creating new renewable energy projects on campus, such as this project’s proposed CS array. 28.71% of the survey respondents saw the potential of the new array on the MUB to advance education and engage students through using the array for course projects or labs (Lynch and Tsitsiragos, 2017) (see Appendix D). The report concludes with a third chapter, discussing the potential legacy of CS at WWU and barriers seen in the institutional process of creating renewable energy projects on campus.

4.5- Site Assessment

A site assessment was conducted for the MUB. The assessment was completed by Western Solar Inc., a Bellingham based solar installation company (see Appendix E). The results of the assessment show the MUB is suitable for a 54 kW solar PV array using 180 300w Itek Energy SE modules and 5 Hi-Q TrueString 480Vac 8 kW Inverters. The array is estimated to produce 52,430 kWh/year with a warrantied module degradation rate of 0.08% per year. Overall, the installed price is $163,081 ($3.02/watt) with $14,188 in local and state taxes totaling $177,269 altogether (Table 5) (Western Solar Inc., 2017). This information fed directly into the financial models.

Table 5- Solar PV System Costs

| | | | |
|---|---|---|---|
| System Size: watts | 54000 | | |
| Annual kwh | 52430 | | |
| Installation Costs Before Tax | $ 3.02/watt + $1200 Bid Bond | $ | 163,081.00 |
| State Sales Tax | 0.065 | $ | 10,600.27 |
| Local Sales Tax | 0.022 | $ | 3,587.78 |
| Total Tax | | $ | 14,188.05 |
| Overall cost | | $ | 177,269.05 |

Data from Western Solar Inc. 2017

### 4.6- Financial Model Results

Two financial models were considered, a non-profit model using a non-profit CS administrator and a for-profit using a for-profit company developing and administering the CS project.

#### *4.6.1- Non-profit CS*

The Non-profit CS model (see Appendix F) is based on the site assessment for the MUB and uses the WWUF as the CS administrator with a 10-year flip ownership structure. The MUB is located between the softball field and soccer field on the south end of WWU's campus (see Appendix B). This location is considered ideal due to the building's recent construction (2014), metal roof,[2] solar resources (see Appendix A), [3] shading,[4] accessibility,[5] and visibility to students and community.[6]

[2] Metal roofs with raised seems are easier to install solar arrays on and lower installation costs.
[3] Annual hours of sunlight measured in kWh/day.
[4] No trees or other structures shading the roof of the building.
[5] Low to the ground, easily accessible components.
[6] Athletic bleachers on two sides, main road east of the building, popular pedestrian path to and from campus.

The CS project would be administered by the WWUF. As a 501 (c)(3) non-profit organization with close ties to WWU, the WWUF would be an ideal partner to administer CS on WWU's campus. Furthermore, the WWUF's status as a non-profit enables the project to more easily take advantage of the WASPI.[7] To create the CS project the WWUF would lease the roof of the MUB and build the solar PV array through a solar installer. The WWUF would be responsible for recruiting the CS participants and building, maintaining, and insuring the array. These participants could be any PSE customers within PSE's service area,[8] and would be recruited through WWUF's fundraising network. The capital needed for the initial building of the array would come from upfront participant payments. The amount of money the participants provide to the WWUF is proportional to their ownership of the array.[9] The energy produced from the array would feed into WWU's campus grid.[10] WWU would be responsible for compensating the WWUF for the energy produced by the array through a Solar Service Agreement (SSA). The SSA defines the supply of solar power and any associated services such as maintenance of the array between the array owners and the array host. Specifically, the "system owner designs, installs, and maintains the system (a set of solar services) and signs an agreement with the host to continue to provide maintenance and solar power" (Coughlin et al., 2010, 4). There would also be need for an interconnection agreement with Puget Sound Energy (PSE) through their schedule 150 attachment B, schedule 151, and schedule 152. The value of the energy produced by the array is determined as the same rate WWU is paying to PSE. WWU would pay this rate to the

[7] WASPI requires certification and annual registration for for-profit CS companies. Non-profit administrators only require a certification.
[8] WASPI requires CS participants to be within the same electricity utility service area as the PV array.
[9] For example, a participant who provides 10% of the initial funding needed for the project would then receive 10% of the financial benefits.
[10] WWU has a single feed in point from PSE. For energy to flow back on to the grid, WWU would need to produce more electricity than it consumes. Subsequently, all energy produced on campus .0is also consumed on campus.

WWUF to compensate them for the energy produced from the array. This income for the energy created from the array would be passed on to the participants in proportion to their ownership of the array. WWUF would also pass on the WASPI to the participants in proportion to their ownership. The participants also receive the “non-power attributes” of the CS array.[11] The CS project as described would run for a period of 10 years. This time frame allows the participants to receive 85% of their upfront payment back. At the end of the 10 years, WWU would buy the array from the WWUF. The buyout price would be determined by an assessor at the end of the 10 years but can be estimated to be between a minimum of $36,830.93 and maximum of $50,621.15 (see Appendix G). The money from the buyout could possibly be used by the WWUF for an energy scholarship or to start a green revolving fund for the WWUF. After the buyout of the array by WWU, the CS would end.

The non-profit model assumes a 2% annual increase in PSE's schedule 24 electricity rate, and a WASPI of $0.18/kWh for 8 years. Income for the CS project comes from three sources: 1) the value of the energy produced,[12] 2) the WASPI, [13] and 3) the ITC.[14] Income from the sale of energy to WWU is managed by the WWUF, the WASPI is paid to individual participants by PSE and the ITC must be claimed by individual participants on their own taxes. There are several annual and one-time costs associated with the management of a CS project. Annual costs include

[11] The “renewable” part of the renewable energy, which participants claim, not WWU, even though the energy is being consumed on WWU’s campus.
[12] Measured in kWh and paid by WWU.
[13] Paid to CS participants by PSE, though funded by the state.
[14] See the ITC section of this report for more information.

insuring the array,[15] cleaning the array,[16] leasing the roof from WWU,[17] and administrative costs[18] (Table 6). The one-time costs include advertising the array in the recruitment of participants,[19] system purchase and installation costs $177,269.05,[20] and purchasing an electricity meter to measure production of the array from PSE[21] (Table 7).

Table 6- Annual Community Solar Project Costs

| | | |
|---|---|---|
| Aministration | $ | 1,080.00 |
| Cleaning | $ | 500.00 |
| Insurance | $ | 990.00 |
| Lease | $ | 12.00 |
| Total | $ | 2,582.00 |

Table 7- One Time Community Solar Project Costs

| | | |
|---|---|---|
| Advertising | $ | 500.00 |
| System Costs | $ | 177,269.05 |
| Production Meter | $ | 92.00 |
| Total | $ | 177,861.05 |

It is important to note that the money received from the WASPI and the value of the energy produced are not retained by the WWUF but are instead managed by the WWUF who then passes the money on to the participants. However, the annual costs (such as cleaning and insurance) are paid by the WWUF on behalf of the participants. These bills are paid with the income earned from the energy sold to WWU. After 10 years, the CS program would end, and the array would be bought from the participants for an estimated value of $43,109.04.[22] The 10

[15] $990 quote received from WWUF insurance company HUB Insurance.
[16] Estimated cleaning costs from Western Solar Inc. for a private cleaning company.
[17] No WWU precedent for leasing roof space and no estimate of the lease price could be obtained from WWU. Lease price was estimated at $1 a month due to the lack of information from WWU and close relationship with the WWUF.
[18] Estimating $0.02/watt for administration.
[19] Estimating $500 for marketing though likely lower as the WWUF has preexisting avenues for community outreach and marketing.
[20] Based on Western Solar Inc. Site Assessment.
[21] $92 quote detailed in Western Solar Inc. Site Assessment contract.
[22] Estimate created through PVValue.com with 3% discount rate (Appendix G).

year program length was determined as that time frame allowed for the participants and the WWUF to realize benefits within a reasonable time frame. The estimated value of the array at 10 years is based on the future earnings of the array and discounted by 3%.[23] This estimate was created through a report from PVValue which estimates the value of solar arrays based on multiple variables. The report also provided an estimated maximum value of $50,621.15 and an estimated minimum of $37,100.93 (Appendix G). At the time of the buyout, the CS participants would only have made back $152,048.76 of the original $177,861.05 costs (85%), leaving the participants $25,812.29 (15%) from solvency. However, with the buyout price of $43,109.04 the participants would become solvent and the remainder of the buyout price, $17,296.75, could be used by the WWUF to further their mission in support of WWU (Table 8).[24]

Table 8- Net Benefit to WWUF

| | | |
|---|---|---|
| Cash Position | $ | (25,812.29) |
| Buy out Price | $ | 43,109.04 |
| Net Benefit | $ | 17,296.75 |

For WWU, the purchase price is added to the future costs of owning the array for the remainder of the array's lifespan (approximately 15 years) with a total cost of $61,103.54.[25] However, the future earnings from the array are estimated to be $98,278.18, which would provide WWU with a saving of $37,174.64 over the reaming 15 years of the arrays life (Table 9). The savings could be used to support the Sustainable Action Fund, a green revolving fund, or for future scholarships.

[23] 3% Discount rate is based on the NREL Technical Assistance Final PowerPoint.
[24] Though the participants will become solvent through the purchasing of the array buy WWU, these estimates are not discounting the future value.
[25] These future costs include an annual cleaning of the array at $500 and inverter replacement at $10,494.50, based on PVvalue report (Appendix G)

Table 9- Net Benefit to WWU

| | |
|---|---|
| Future Costs | $ 17,994.50 |
| Buy out Price | $ 43,109.04 |
| Future value | $ 98,278.18 |
| Net Benefit | $ 37,174.64 |

*4.6.2- For-profit Model*

For-profit CS has the potential to be more financially beneficial than non-profit CS due to the increased availability of tax incentives for the CS company[26] developing the project. A CS company is a for-profit organization which can develop and administer the CS project. The company can be the owners of the array and the CS participants could subscribe to the array. While this organization has not been identified, some general characteristics can be anticipated, such as a large tax appetite[27] to take advantage of the federal ITC[28] and MACRS[29] tax incentives. Furthermore, the CS company needs the administrative capacity to manage a minimum of 10 CS participants.[30] Owning and administering the CS project requires the CS company to build the array, lease the roof from WWU,[31] insure the array, recruit the participants, and financing the project. The CS company is also required to provide Community Solar Services defined by WA state as "the provision of electricity generated by a community solar project, or the provision of the financial benefits associated with the electricity generated by a community solar project, to

[26] A Community Solar company is defined by WASPI as "a person, firm, or corporation, other than an electric utility or a community solar cooperative, that owns a community solar project and provides community solar project services to project participants" (RCW 80.28.370).
[27] Meaning the ability of the organization to take advantage of federal tax incentives.
[28] See ITC section for more information.
[29] See MACRS section for more information.
[30] WASPI requires a minimum of 10 CS participants or one for every 10 kW of capacity, whichever is greater.
[31] Due to the CS company's for-profit status an estimated $37.5 per a month lease rate was used as opposed to the $1 rate used for the non-profit model.

multiple project participants, and may include other services associated with the use of a community solar project such as system monitoring, maintenance, warranty provisions, performance guarantees and customer service" (RCW 80.25.370). The developer is also responsible for maintaining registration with the Washington State University Energy Extension Program as a CS company required by the WASPI. The CS participants can be anyone within PSE's service area.[32] Though financed by the CS company, the CS participants would pay a monthly subscription fee. The fee covers the administrative costs and provides the participant with their portion of the energy produced. This CS structure allows the CS company to maintain full ownership of the array and the subsequent federal incentives while providing the participants with the financial benefits of the array in the forms of the WASPI, value of the energy produced, and the non-financial benefits in the "nonpower attributes".[33] The energy produced from the array would feed into WWU's electrical system and be used on campus.

A Solar Service Agreement (SSA) will be required between the developer and WWU to define the supply of power and maintenance responsibilities. The CS company will also need an interconnection agreement with PSE. The value of the energy in kWh is be determined by the same rate that WWU is paying PSE for electricity. The value of the energy is then be passed on to the participants through the development company. The CS project continues for 10 years after which time WWU buys the array from the CS company and the CS project will end.

[32] WASPI requires CS participants to be within the same electricity utility service area as the PV array (RCW 82.16.165).

[33] Meaning the "renewable" part of the renewable energy is claimed by the participants and not WWU even though the energy is being consumed on WWU's campus.

At the end of this 10-year period the CS company would have made $6,161.32 on their investment (Table 10). WWU would purchase the array from the CS company for $43,109.04[34] (see Appendix C and G). This estimated value of the array is based on the future earnings of the array after the first 10 years and discounted by 3%.[35] However, the PVValue report also provided an estimated maximum value of $50,621.15 and a minimum of $36,830.93. Overall the CS company would receive $49,270.36 on their investment after the 10 years.

Table 10- Community Solar Company Net Benefit

| | | |
|---|---|---|
| Cash Position | $ | 6,161.32 |
| Buy out Price | $ | 43,109.04 |
| Net Benefit | $ | 49,270.36 |

For WWU, the purchase price is added to the future costs of owning the array for the remainder of the arrays lifespan totaling $61,103.54.[36] However, the future earnings in energy savings from the array are estimated to be $98,278.18, providing WWU with an energy saving of $37,174.64 over the remaining 15 years of the arrays life (Table 11).[37] This savings could be used to support the Sustainable Action Fund, a green revolving fund, or for future scholarships.

Table 11- WWU Net Benefit

| | | |
|---|---|---|
| Future Costs | $ | 17,994.50 |
| Buy out Price | $ | 43,109.04 |
| Future value | $ | 98,278.18 |
| Net Benefit | $ | 37,174.64 |

[34] Estimate created with 3% discount rate (Appendix C)
[35] 3% Discount rate is based on the NREL Technical Assistance Final PowerPoint.
[36] These future costs include an annual cleaning of the array at $500 and inverter replacement at $10,494.50, based on PVvalue report (Appendix G)
[37] It should be noted that this table is identical to the non-profit CS model.

*4.6.3- Sensitivity Analysis*

These financial models show two potential forms for CS development at WWU, however, the analyses have caveats, which have implications on the model outputs. One key funding point for both the non-profit and for-profit CS models in the WASPI. This incentive rate is based on the fiscal year the array would be built and certified. The two models outlined use a WASPI rate of $0.18/kWh for 8 years, assuming the array is constructed and certified in fiscal year 2019 and is built with solar panels produced in Washington state. Yet, if the array was built and certified in the fiscal year of 2020 the production incentive would be reduced to $0.15/kWh. The reduction in WASPI results in a $12,000 loss of revenue for the projects. Resulting in lower return for both the CS company and the WWUF. Though less influential on the for-profit model the loss of $12,000 for the non-profit model significantly reduces the net benefit to the WWUF to $5,296.75. The potential for a delayed construction date of the CS project is likely as WWU is a complex organization which moves very slowing on infrastructure projects. Furthermore, WWU is a large organization, and as such, there is the potential for turnover in key positions which may further hinder the CS project. In an already sluggish process, any changes in leadership or in key positions has the potential to bring CS to a halt on WWU's campus.

Another aspect of the financial analysis which has the potential to be variable is the amount of energy produced from the solar panels. The Itek 300 Watt SE solar panels are warrantied to degrade at no more than 0.8% per year. Yet, it is common for these panels to degrade at 0.5% per year. Allowing for an increase in energy production and ultimately an increase in revenue for both financial models. The increase in energy production could result in an additional $1,500 net benefit to the CS company or for the WWUF. WWU also has the potential to benefit from the decrease in degradation rate as they would own the array the last 15 years of the arrays life span and could gain an additional $5,250.

Both financial models relied heavily on federal tax incentives. The non-profit model takes advantage of section 25D investor tax credit (ITC). This tax credit allows for a dollar for dollar reduction in taxes paid by the recipient, potentially providing up to 30% of the installation costs back on year one. Yet, federal tax law is not clear on how or if the ITC should be applied to CS.[38] The ambiguity of the ITC allows for it to potentially be claimed by CS participants, but it is not a guarantee and is dependent on the participant's individual tax appetite. Specifically, the CS participants need passive income to use the ITC, as the ITC was gained through a passive enterprise.

The for-profit CS financial modeling relies on section 48 of the ITC but also on the federal modified accelerate cost recovery system (MACRS) for depreciation. Unlike the ITC, MACRS is not a direct dollar for dollar reduction in tax that would otherwise have to be paid but instead a deduction in taxable income. Together the ITC and MACRS provide an additional $98,000 to the CS company. The CS company has the potential to more easily take advantage of the ITC since they are the single owners of the array and would not need passive income. The CS company does, however, need a very large tax appetite to take advantage of both the ITC and MACRS. This need for a large tax appetite would exclude many small businesses from the full benefits of federal tax incentives as they would not have a large enough tax appetite.

[38] See page 10 for details on the ITC

## 4.7- Financial Model Comparison

The main difference between models 1 and 2 are the non-profit and for-profit tax status. This difference allows the CS company to take advantage of federal tax incentives including the ITC and MACRS. But these additional revenues are based on the assumption the CS company will have the large tax appetite needed to take advantage of all of the federal tax incentives. Another difference is the for-profit model also has to manage the increased regulation by the WA State Utilities and Trade Commission (UTC). This regulation includes annual registration fees and repercussions, including the loss of the incentive, if the rules are not followed.

A second difference in the financial models is the lease price for the roof of the MUB. Due to the lack of precedent for leasing roof space from WWU, no estimate was provided by WWU. For these models two different estimates were created, the for-profit lease estimated $450 a year and is based on windfarm lease pricing[39] while the non-profit estimate was $12 year. The difference in pricing is assumed as the non-profit model would be administered by the WWUF. The WWUF has very close ties to WWU and its organizational mission is to help support the university, due to this a low lease rate used. In turn, the for-profit model assumes a private CS company would lease the MUB roof and as this company has no altruistic motives and no ties to WWU, a higher rate was used.

An additional difference between the two models is the administration and marketing costs. For the non-profit model administered by the WWUF, the marking costs are estimated to be quite low at $500. This low cost is due to the existing marking infrastructure and networks the WWUF

[39] For-profit lease based on $10,000/wind turbine/year (Durbin, 2010) (assuming a 1.2 MW turbine) equates to $0.0083/watt. $0.0083*54000 (proposed CS array size) = $450/year.

already has in place as a part of their fundraising role for WWU. The for-profit CS model, however, is assumed to be lacking this marketing infrastructure. Due to this assumed deficiency, the for-profit model estimates a cost of $5,400 for CS marketing[40].

Table 12- Comparison Table of For-Profit and Non-Profit Community Solar

| **Revenue Over 10 Years** | For-Profit 1 | Non-Profit 1 |
|---|---|---|
| Buy Out | $ 43,109.04 | $ 43,109.04 |
| ITC | $ 53,180.71 | $ 53,180.71 |
| MACRS | $ 45,203.61 | |
| Value of Energy | $ 51,269.34 | $ 51,269.34 |
| WASPI | $ 73,418.71 | $ 73,418.71 |
| Total | $ 266,181.41 | $ 220,977.80 |
| | | |
| **Costs Over 10 Years** | For-Profit 1 | Non-Profit 1 |
| Adminstration/Billing | $ 10,800.00 | $ 10,800.00 |
| Cleaning | $ 5,000.00 | $ 5,000.00 |
| Insurance | $ 9,900.00 | $ 9,900.00 |
| Lease | $ 4,500.00 | $ 120.00 |
| Marketing | $ 5,400.00 | $ 500.00 |
| Production Meter | $ 92.00 | $ 92.00 |
| System Costs | $ 177,269.50 | $ 177,269.50 |
| WASPI Registration | $ 450.00 | |
| WASPI Annual Update | $ 3,500.00 | |
| Total | $ 216,911.50 | $ 203,681.50 |
| | | |
| **Net Benefit** | For-Profit | Non-Profit |
| Revenue | $ 266,181.41 | $ 220,977.80 |
| Cost | $ 216,911.50 | $ 203,681.50 |
| Net | $ 49,269.91 | $ 17,296.30 |

Note the net benefit value in the for-profit model is for the CS company, while net benefit value in the non-profit model is for the WWUF.

[40] Administration costs are based on Chwasthy et al., (2018) with an estimated $0.10/W for CS projects under 1MW.

## 5 - Recommendation

Based on the analysis of the financial models, the recommendation for hosting CS on WWU is to adopt the Non-Profit model.

*Siting the Array*

The recommended site for the solar array is on WWU's MUB's roof. This location is ideal due to the building's recent construction (2014), metal roof, solar resources, and visibility to students and the community. For WWUF to build the array on the MUB roof, the WWUF would need to lease the roof space from WWU. As there is no precedence of this type of rental arrangement, the model used a lease of $1 a month.

*CS Administration*

The WWUF would administer the CS project. As a 501 (c)(3), non-profit organization with close ties to WWU and a mission to perpetuate WWU, the WWUF would be an ideal organization to administer the CS project. The WWUF's status as a non-profit is beneficial as it enables the project to take advantage of the WASPI (RCW 82.16.165) without the regulations required of for-profit CS companies. The WWUF would be responsible for leasing the MUB's roof from WWU, building the array, maintaining it, insuring it, and recruiting the CS participants.

*Participants*

CS participants can be any individual within PSE's service area[41] and would be recruited through the WWUF's existing alumni networks and community outreach methods.

*Initial Financing*

The initial capital needed to build the array would come directly from participants recruited by the WWUF who would provide funding upfront. The amount of money the participants provide to the WWUF is proportional to their ownership in the array.

*Program*

The energy produced from the array would be fed into WWU's campus grid. To compensate the WWUF and CS participants for the energy produced from the array, a SSA is necessary. A SSA outlines the agreement between the host site, WWU and the WWUF, for the provision of energy and any service requirements such as maintenance of the array. The WWUF would also be responsible for an interconnection agreement with PSE. The value of energy is determined by the same rate WWU is paying to PSE. The revenue for the energy created from the array would be passed on to the participants in proportion to their ownership in the array. The WWUF would also pass on the WASPI (RCW 82.16.165) to the participants in proportion to their ownership and the array's production. Though the energy produced from the array is used on WWU's campus, the non-power attribute (i.e. green energy benefits) of the energy produced is associated with the CS participants as per the WASPI (RCW 82.16.165). The project as described would

[41] WASPI requires CS participants to be within the same electricity utility service area as the PV array.

run for a period of 10 years. This time frame would allow the participants to break even on their upfront payment to the WWUF.

*Program Termination*

At the end of the project, WWU would purchase the array from the WWUF. The buyout price would be determined by an assessor at the end of the 10 years, however, a minimum price would be determined during the initial lease agreement and contract with WWU. The money from the buyout would then be used by the WWUF to ensure all participants were able to break even on their upfront payments, with all remaining funds used to further the WWUF's mission. After the buyout of the array, WWU would be the sole owner of the array and receive all energy savings and environmental benefits for the remained for the array's lifespan, approximately 15 years.

Table 13- Recommendation Cash Flow

| | Participants | Foundation | WWU | Gov. Agencies | Notes |
|---|---|---|---|---|---|
| Recuitment of Participants | | $ (500.00) | | | Cost paid by Foundation to recruit particpants |
| Construction - Financing | $ (177,269.50) | $ 177,269.50 | | | Cost of array, funded by participants, transfer to WWUF |
| Construction - Contractor | | $ (177,269.50) | | | Payment to Contractor |
| | | | | | |
| Administration of CS Project | | $ (25,912.00) | | | Cost to maintain and insure array for 10 years |
| Energy Produced from Array (Years 1-10) | $ 25,357.34 | $ 25,912.00 | $ (51,269.34) | | Payment from WWU to Participants and Foundation |
| Energy Expense Offset | | | $ 51,269.34 | | Savings achieved by WWU |
| Government- (Federal) Tax Credit | $ 53,180.71 | | | $ (53,180.71) | Tax Credits flowing to particpants |
| Government- (State) Production Incentive | $ 73,418.71 | | | $ (73,418.71) | Tax Credits flowing to particpants |
| | | | | | |
| WWU Purchase Array at Year 10 | $ 25,313.00 | $ 17,796.04 | $ (43,109.04) | | Year 10, WWU purchases array from WWUF |
| Array Maintenance (Years 11-25) | | | $ (10,494.50) | | WWU maintenance Costs |
| Energy Savings (Years 11-25) | | | $ 116,000.00 | | WWU energy savings years 11-25 |
| **Net Return or Savings** | $ 0 | $ 17,296 | $ 62,396 | $ (126,599) | |
| | | | | | |
| Return to WWUF at year 10 | | $ 17,296 | | | |
| Net energy savings to WWU over 25 years | | | $ 62,396 | | |

Cash flow outlining the movement of funds through the project.

## 6 - Discussion

When developing energy projects, there are two competing parts of the equation. One is the financial or economics of the project (Cost). The other side is the energy benefits (Product). Ideally, these two sides help reinforce each other; the product serves its purpose of providing energy (value) while balancing the costs required to build the project. However, within the specific context of renewable energy, this equation is not entirely certain.

Renewable energy projects are often more expensive than their fossil fuel competitors. On the other hand, renewables provide a characteristic which cannot be found in competing energy sources - the environmental benefits (i.e. the lack of carbon production per energy production). This characteristic of renewable energy can change the equation of cost vs. value. Yet, the monetization of the environmental benefits of renewable energy is difficult to evaluate and has a minimal effect on overall project feasibility without the inclusion of policies such as the WASPI (RCW 82.16.165). The involvement of HEIs in renewable energy development further skews the equation. HEIs add both public interest and an educational consideration. The equation of cost vs. value must also take into account ancillary benefits to HEIs such as image, educational resources, normalization, inspiration, and legacy. As these qualities do not have standardized monetary values, their inclusion becomes somewhat of a "feel good" aspect of the project and are not fully incorporated into the equation. For HEIs a highly visible, accessible and student founded CS project could add to the institution’s sustainability commitment, enhance educational opportunities and be used as a marketing tool to attract and retain environmentally-minded students, faculty and staff.

## 6.1- Organizational Concerns

### *6.1.1- Perception*

One aspect of the CS project that has been noticed through working with many of the students and some of the key informants on this project is the lack of consideration for the benefits to the community. CS is meant to increase access to solar energy; this is the fundamental goal of a CS project. Yet, when researching this recommendation, especially in the early stages, many of the students and key informants found CS to be a means to getting a new solar array at WWU. This viewpoint may have been due to the due to the flip ownership structure of the CS recommendation. From this perspective, the CS project seems to be an inefficient and convoluted way of getting a solar array on WWU's campus at a discounted price. A reiteration of the goals for CS was often needed to refocus the attention of some students and key informants. This perspective was not an impediment to the project but could show the isolation of HEI students in terms of community awareness.

### *6.1.2- Organizational Structure*

HEIs are inherently hierarchical organizations and are run by presidents, boards, and vice presidents. As educators of increasingly environmentally focused student bodies, they are also receptive to bottom-up influences. Evidence can be seen in WWU's participation in PSE's Green Direct program, which was initiated by the WWU student body. When initiated in 2019, the Green Direct program will supply WWU with 100% renewable energy through purchasing bundled energy and renewable energy credits. Conversely, the student body’s influence on program participation is more of an exception than a rule. When researching this CS recommendation, the bureaucratic hierarchy of WWU was very evident. As a large organization, WWU has many people who are responsible for considering different aspects of a project such as this CS recommendation. For example, facilities management is responsible for all of the buildings on campus, however, there is also a campus architect who would need to be consulted. Furthermore, WWU's Vice presidents such as the VP for Business and Finance Affairs would need to approve. Facilities management also has union works on campus who may not be amiable to having a solar project on campus owned and maintained by a private non-union company.

Project development at WWU proceeds at a glacial pace. This observation was made by Lynch and Tsitsiragos (2017) in their research on past solar projects at WWU. The process can take years in which time the annually decreasing WASPI will have dropped by several cents per kWh. The annual reduction in the WASPI decreases the finical security of the CS project. Another observation made by Lynch and Tsitsiragos (2017) is the lack of project advising and leadership at WWU. Often, the student body will find energy efficiency or renewable energy projects but have no one point of contact within WWU for help in bringing their ideas to fruition. Furthermore, these potential projects are often unable to find the required information from WWU on how to further their projects. This can often be attributed to a lack of precedent in WWU policies. Altogether, the lack of a single point of contact and precedent results in each student project asking the same questions and learning the same lessons. Limiting the potential innovation of student projects through a lack of information and guidance.

Conversely, WWU has a student funded green grant in the form of the Sustainable Action Fund SAF, which is meant to provide funding for sustainable projects. There is guidance for students to accomplish their sustainability goals within the SAF program, but often the questions needed to be answered for project progression are unprecedented or overlap WWU administrative boundaries. Lynch and Tsitsiragos (2017) suggest a solution in creating a legacy project managed by a campus energy team. The legacy project will allow for one project to be repeated and built upon with guidance from a set group of WWU faculty and staff acting as the campus energy team. An example of this potential legacy project could be an annual 10 kW rooftop solar installation, or energy efficiency upgrades. Each year the legacy project would be overseen by the campus energy team. The legacy project could streamline the process, reducing costs and effectively build renewable energy resources on campus.

## 6.2- Limitations and Restraints

### *6.2.1- Accessibility*

One of the key aspects of CS is to increase access to solar energy for those who are unable to own their array. The recommendation sets out a partial solution to help increase access to solar for community members. Yet, the question of how much more accessible this CS project would make solar, for how many people and by how much, is questionable. The WASPI (RCW 82.16.165) requires a minimum of 10 CS participants. At this level, the initial costs per participant are about $18,000. While significantly less than the costs of installing a solar PV system for each individual on their residence, this initial cost is still quite high and potentially no more accessible than the full costs of a residential solar array. Yet, if the number of CS participants is doubled the costs per participant becomes $9,000, still a large sum. CS may however, increase accessibility to solar energy to those who are renting or have an unfavorable site due to shading, age or orientation. For these people the CS project at WWU would provide an option for solar they would not have otherwise had.

*6.2.2- Research Constraints*

When developing a recommendation for WWU, there was the opportunity to set the groundwork for a real CS project at WWU. Yet, this research of CS is bound by research constraints which narrow the focus of the researcher to a singular place, time and idea for an M.A. project. The restricted focus provides an in-depth understanding of a particular topic, instead of a breath of knowledge. However, this creates an inflexibility to encompass new ideas into the project. While these constraints are ideal for M.A. projects, it becomes a hindrance when simultaneously attempting to set the groundwork for a real CS project. Meaning the research constraints inhibit the ability to improvise and follow the most financially sound options. For example, if developing a CS project for Bellingham was an option instead of focusing at WWU, there would have potentially been a more financially beneficial model to all parties.

*6.2.3- Key Informants Survey*

The results of the Key Informants survey show the high level of knowledge and experience the key informants provided to the process of building a recommendation. Yet, it should be noted only 13 people completed the survey. This small sample size has the potential to exclude more diverse opinions and perspectives. The sample size may also be indicative of the limited CS development in WA state. A larger pool of key informants may have helped to inform a different recommendation, but given the unique proposition of siting the CS array at WWU and the limited degree of CS development in WA State, the key informants provided insightful and necessary guidance.

### *6.2.4- Risks*

CS is a new solar PV ownership model and is not as well established as single owner residential solar PV. CS also requires the participation of multiple parties in different roles. These diverse roles require specific legal structures such as SSAs, lease agreements, federal tax applications, WASPI applications, ownership agreements and service contracts for CS to function. At the center is the WWUF. Though the WWUF is not bearing the financial risk of the CS project, they are responsible for administering the project and virtually ensuring its success. Another risk which influences the potential success of the CS project is the unset future array buyout price. If the buyout price after 10 years of the CS project is substantially lower than the estimated value, the finical benefit to the WWUF becomes questionable. Working within WWU's organizational structure also poses the risk of missing incentive opportunities due to the glacial pace of decision making. Finally, the lack of precedent for the leasing of roof space from WWU provides no estimate for a lease rate to the WWUF.

## 6.3- Conclusion

CS has the potential to reduce costs and increase access to solar energy for many communities. HEIs are favorably positioned in society for developing renewable energy projects as they have the potential to promote sustainability through their role as educators, researchers and the ability to focus faculty, students and staff toward renewable energy goals. HEIs are also able to capitalize on the image of a sustainability focused campus. The results of this research have found a non-profit administered and participant owned CS project to be feasible on WWU’s campus with the WWUF as the CS administrator. The MUB is the best site for the CS array on WWU's campus. According to the preferred non-profit model, the array would be financed through upfront payments from the CS participants to the WWUF. There are many applicable state and federal regulations that influence CS in Washington. These policies include the WASPI, Net Metering, Federal ITC, MACRS, and SEC regulations. The benefits to WWU are primarily energy-based savings and the improvement of WWU’s image as a sustainability-oriented campus. The WWUF is benefited through an end of project payment, increased ties with the community, and helping to support WWU. The CS participants bear the upfront costs of the project but will receive annual payments for reimbursement, reduce their carbon footprint, and help support WWU and the WWUF while breaking even on their investment. The CS recommendation does come with some risks, such as the potential for missed WASPI payments due to slow administrative procedures at WWU, uncertain array buyout price, uncertain lease price and the responsibility of the WWUF to ensure the project’s success. Despite these reservations CS at WWU will help position the university as a leader in sustainability and provide more accessible solar energy for the community. Though significant will power is needed from WWU and the WWUF to overcome the risks and uncertainties of the recommendation.

## 7 - Post-Script

Through the process of building this recommendation, several informative insights were brought to light which may prove useful for future students or staff who are considering CS, or solar arrays in general, at WWU. These insights may also be informative to others considering CS on HEIs campuses, but are based on observations made while creating the recommendation for WWU. The recommendation attempted to bridge the needs of a successful CS project with the requirements and realities of working on and with an HEI. For future students and staff, a critical look should be taken at the two spheres of CS and solar at a HEIs.

### 7.1- Community Solar

If the goal for a CS project is to increase accessibility to solar energy for people who do not have the means or have unsuitable siting options, then it would be best to site the CS project off of the HEIs property. This change in siting could reduce labor costs because the project would not be required to pay prevailing wages, currently a requirement for all work completed on state property. Furthermore, it would reduce challenges associated with working within the administrative bureaucracy of an HEI. Ideally, locating the array off campus would reduce costs and streamline the implementation process. This shift in siting also opens up new possibilities for an increase in array size allowing for economies of scale to reduce the $/watt. Finally, the off-campus siting would mitigate perception issues from university students and staff who only see CS as means for WWU to receive a solar array at a discounted rate.

7.2- Solar at HEI

For WWU, the prospect of CS on campus is in line with the university's goals, yet there are many barriers, and it may be more useful for the university to consider single (WWU) ownership of a solar array on campus. This potential project would follow the two existing demonstration arrays on campus, the Environmental Studies array and the Viking Union array. These two projects were very expensive for minimal energy output and offer little opportunity for student engagement, and are not accessible or very visible. Building off the site assessment for the Multiuse Building, future students could work with the Office of Sustainability to construct the array with funding from the Sustainable Action Fund. The array would not be eligible for the state production or any federal tax incentives and the labor costs would be above average due to prevailing wages. The array would, however, have cheaper material costs as out of state panels could be purchased. The project would also be much more visible, showing WWU's support of sustainable and renewable energy initiatives, and the energy produced would be much more significant compared to the two existing arrays on campus.

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# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – A

**Energy Systems Synthesis Final Presentation**

# Bright Futures Consulting

**Implementation of a Community Solar Project on Western's Campus**

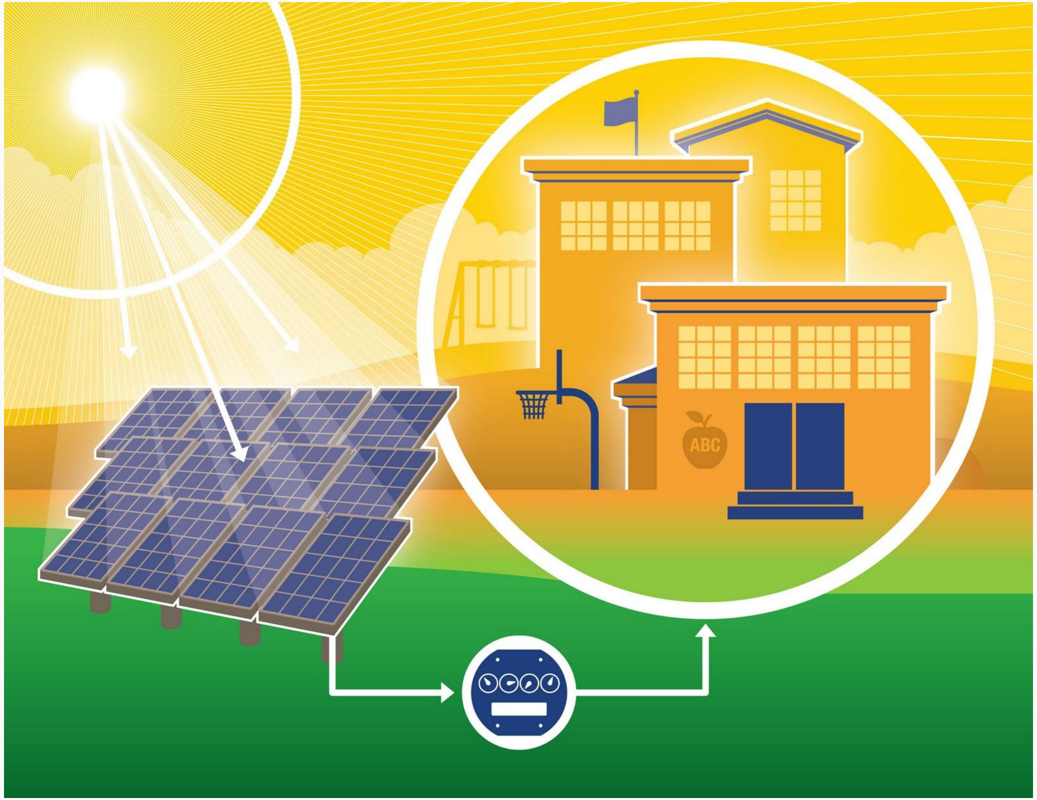
Energy 490 Capstone Class

Kellen Lynch, Aden Nevler, Nate Muir, Stella Tsitsiragos, Garret Harp, Anna Kemper

# Community Solar

- *Community solar* is a solar energy deployment model that allows customers to buy or lease part of an off-site shared solar PV system without having to install a system on their own residential or commercial property.

  <u>Common Models:</u>
- Utility Model
- Special Purpose Entity
- Non-Profit Model



# Comparison of Community Solar Models

| Administered by | Utility | Special Purpose Entity | Non-profit |
|---|---|---|---|
| Owned by | Utility or 3rd party | SPE members | Non-profit |
| Financed by | Utility, grants, ratepayer subscriptions | Member investments, grants, incentives | Donor contributions, grants |
| Hosted by | Utility or 3rd party | 3rd party | Non-profit |
| Subscriber Profile | Electric rate payers of the utility | Community investors | Donors |
| Subscriber Motive | Offset personal electricity use | Return on investment; Offset personal electricity use | Philanthropy |
| Long-term Strategy of Sponsor | Offer solar options<br><br>Add solar generation (possibly for Renewable Portfolio Standard) | Sell system to host<br><br>Retain for electricity production for life of system | Retain for electricity production for life of system |
| Examples | Sacramento Municipal Utility District – Solar-Shares Program<br><br>United Power Sol Partners | University Park Community Solar, LLC<br><br>Clean Energy Collective, LLC | Solar for Sakai |

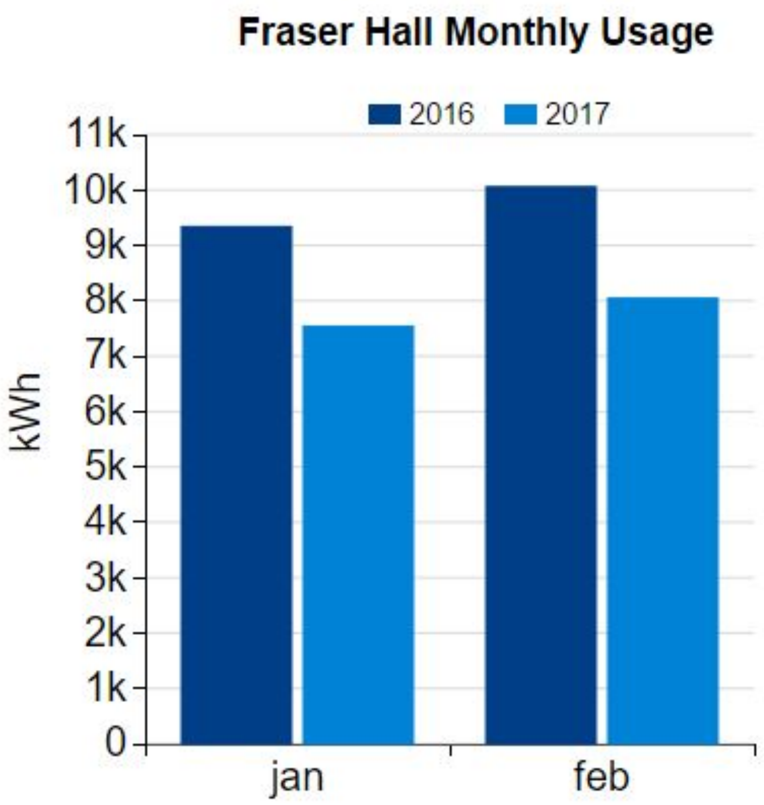
# Context

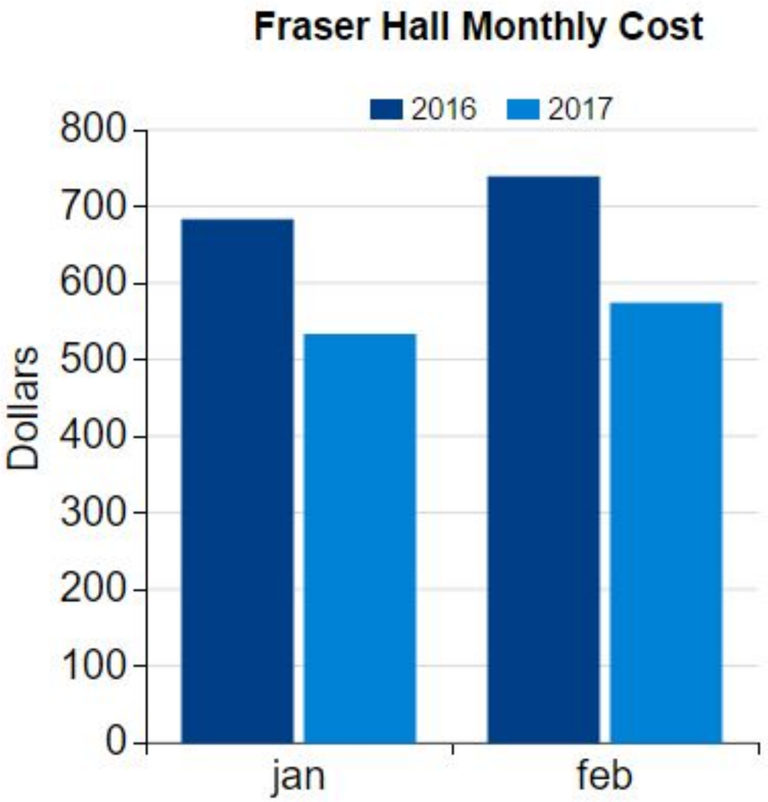
## Campus Electricity Overview

WWU's annual electric consumption: 32 million kWh
WWU's annual electricity cost: $2.4 million
WWU's annual CO2 output from electricity: 2,500 metric tons

## Proposed 40 kW System

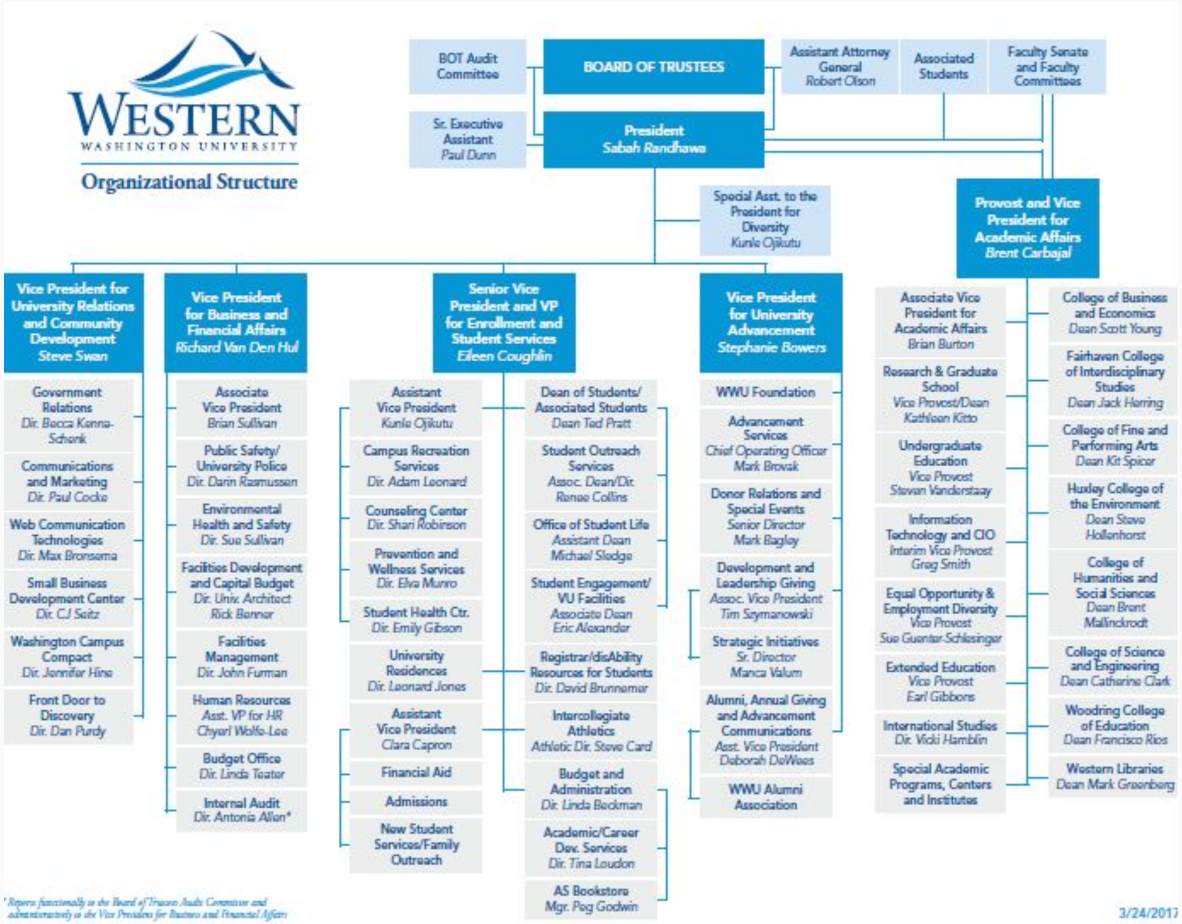
Bright Future's possible project cost: 40,000 watts at $3.75 / watt (in-state) = $150,000
Projected annual savings for university: 44,000 kWh at $0.085/watt = $3,740
Projected CO2 offset from array: 31 metric tons
Summary: Installing a 40 kW solar system on campus, our solar generation of 44,000 kwh annually can match 50% of the electricity demands for Fraser Hall or the university bookstore.


Fraser Hall Monthly Usage
2016
2017
11k
10k
9k
8k
7k
6k
5k
4k
3k
2k
1k
0
kWh
jan
feb


Fraser Hall Monthly Cost
2016
2017
800
700
600
500
400
300
200
100
0
Dollars
jan
feb

# On Campus Approval

- Facilities Management
  -John Furman
- Facilities Development & Capital Budgeting
  -Rick Benner
- Office of Sustainability
  -Seth Vidana
- The Student Body and AS



# On Campus Approval

Timing:

- Fall Meeting
- Winter Proposal
- Future Implementation

# Costs

| Cost Breakdown | $ | |
|---|---|---|
| Module cost: | $1.00/watt (WA) | $.45/watt (Asia) |
| Inverter Cost: | $.35/watt | |
| Racking cost: | $.35-.95/watt | |
| Labor Cost | $.95/watt | |
| Overhead Cost: | $.35/watt | |
| Bid Bonding: | $5,000-$10,000 | |
| Overall: | $3.00-4.00/watt | |

Source: Markus Virta, Western Solar

# Low Cost Assumptions

| | | | |
|---|---|---|---|
| Module Cost: | $1.00/watt | @40,000 watts | = $40,000 |
| Inverter Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Racking Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Labor Cost: | $.95/watt | @40,000 watts | = $38,000 |
| Overhead Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Bid Bonding: | $5,000 | | = $5,000 |
| Overall cost: | $3.00/watt + $5000 | @40,000 watts | **=$125,000** |

# Moderate Cost Assumptions

| | | | |
|---|---|---|---|
| Module Cost: | $1.00/watt | @40,000 watts | = $40,000 |
| Inverter Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Racking Cost: | $.65/watt | @40,000 watts | = $26,000 |
| Labor Cost: | $.95/watt | @40,000 watts | = $38,000 |
| Overhead Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Bid Bonding Cost: | $7,500 | | = $7,500 |
| Overall Cost: | $3.30/watt + $7,500 | @40,000 watts | **= $139,500** |

# High Cost Assumptions

| | | | |
|---|---|---|---|
| Module Cost: | $1.00/watt | @40,000 watts | = $40,000 |
| Inverter Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Racking Cost: | $.95/watt | @40,000 watts | = $38,000 |
| Labor Cost: | $.95/watt | @40,000 watts | = $38,000 |
| Overhead Cost: | $.35/watt | @40,000 watts | = $14,000 |
| Bid Bonding Cost: | $10,000 | | = $10,000 |
| Overall Cost: | $3.60/watt + $10,000 | @40,000 watts | **= $154,000** |

# Operating and Maintenance Costs

| | | |
|---|---|---|
| Module Cleaning | $150 per year x 25 years | = $ 3,750 for 25-year life |
| Monitoring/ Connectivity Upkeep | $50 per year x 25 years | = $1,250 for 25-year life |

# Revenue: Avoided Cost of Electricity

| Year: | $: |
|---|---|
| 1 | $3,758 |
| 2 | $3,814 |
| 3 | $3,871 |
| 4 | $3,929 |
| 5 | $3,987 |
| 6 | $4,046 |
| 7 | $4,107 |
| 8 | $4,168 |
| 9 | $4,230 |
| 10 | $4,293 |
| 11 | $4,357 |
| 12 | $4,422 |
| 13 | $4,488 |
| 14 | $4,555 |
| 15 | $5,623 |
| 16 | $4,691 |
| 17 | $4,761 |
| 18 | $4,832 |
| 19 | $4,904 |
| 20 | $4,977 |
| 21 | $5,052 |
| 22 | $5,127 |
| 23 | $5,203 |
| 24 | $5,281 |
| 25 | $5,359 |

- Sum of avoided costs of electricity (revenue stream)= $113, 835
- Present Value of $45, 842 (8% discount rate)

# Incentives

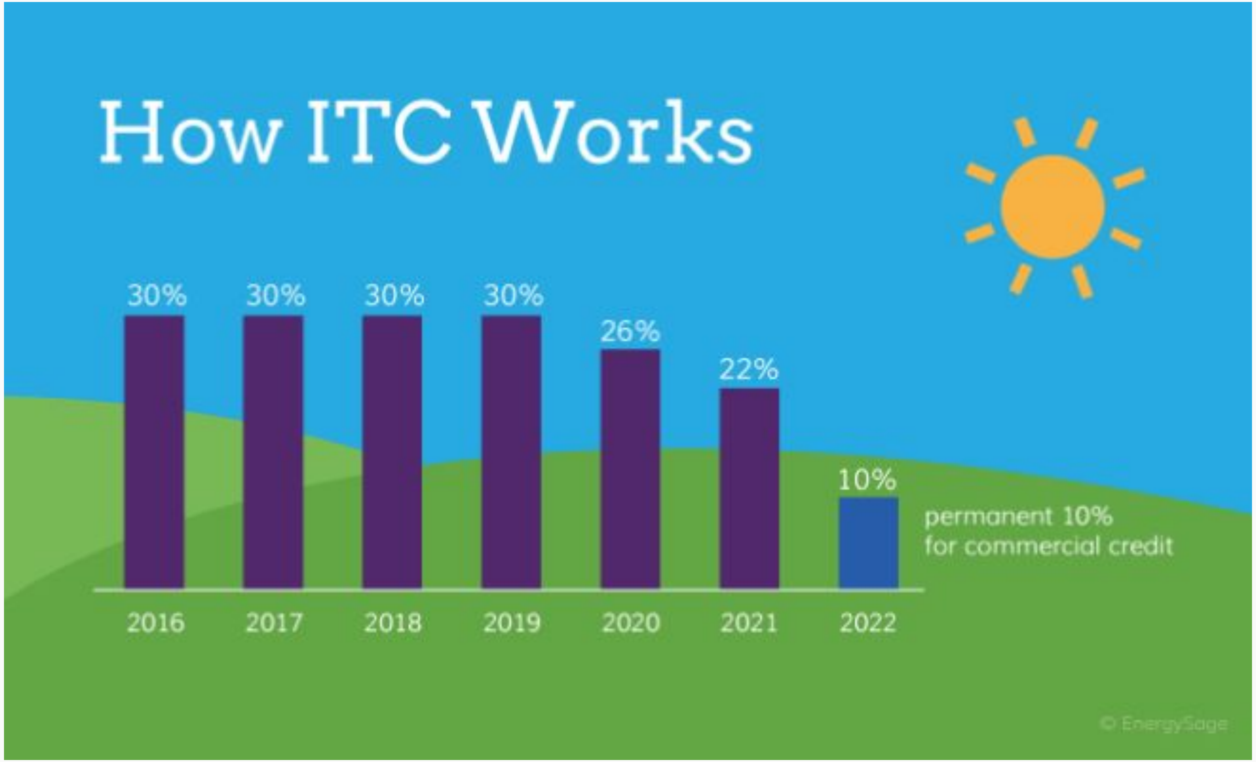
<u>Federal Incentives</u>

- Solar Investment Tax Credit
- MACRS  Depreciation

<u>Washington State Incentives</u>

- Washington State Production Incentive
- Washington State Sales Tax Exemption
- Net Metering

# Solar Investment Tax Credit



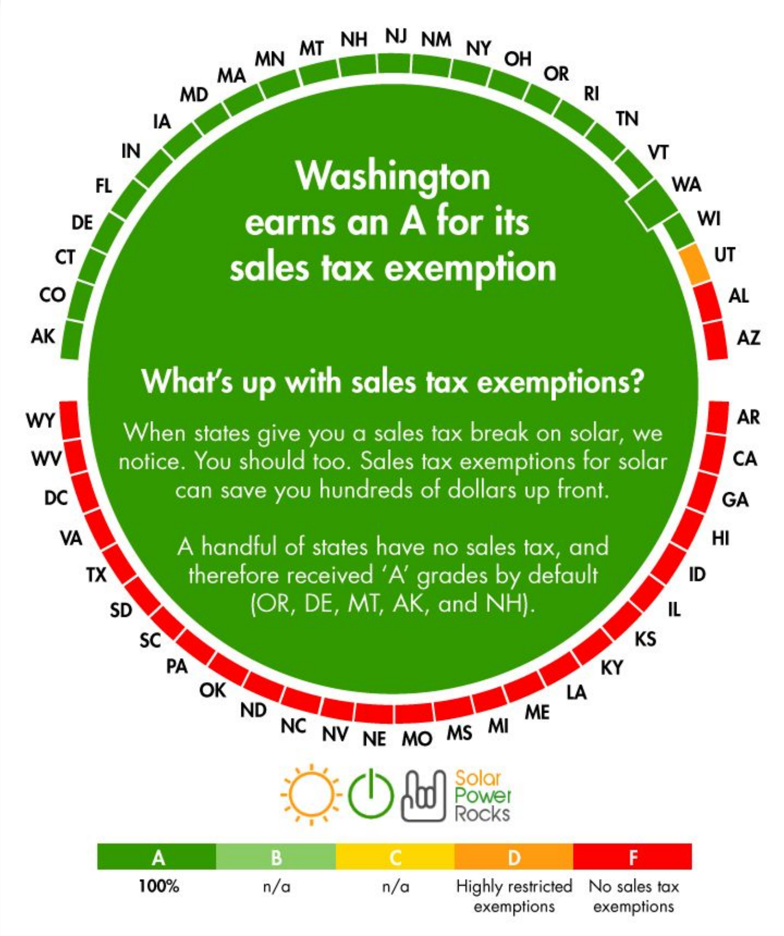
# MACRS Depreciation

| Year | Depreciation rate for recovery period | | | | |
|---|---|---|---|---|---|
| | 3-year | 5-year | 7-year | 10-year | 15-year |
| 1 | 33.33% | 20.00% | 14.29% | 10.00% | 5.00% |
| 2 | 44.45 | 32.00 | 24.49 | 18.00 | 9.50 |
| 3 | 14.81 | 19.20 | 17.49 | 14.40 | 8.55 |
| 4 | 7.41 | 11.52 | 12.49 | 11.52 | 7.70 |
| 5 | | 11.52 | 8.93 | 9.22 | 6.93 |

Solar Investment x 85% x Depreciation Rate x Assumed Tax Rate

ex) Year 1 : $150,000 x 0.85 x 0.20 x 0.33 = $8,415
Year 2 : $150,000 x 0.85 x 0.32 x 0.33 = $13,464

# Washington State Sales Tax Exemption




**Systems less than 10 kW**

100% sales tax exemption

**Systems greater than 10 kW**

75% sales tax exemption

# Washington State Production Incentive

| Type of System | (Proj.) 2018 $/kWh | (Proj.) 2019 $/kWh | (Proj.) 2020 $/kWh |
|---|---|---|---|
| | **Community Solar** | **Community Solar** | **Community Solar** |
| Solar Modules and Inverter Both Manufactured in Washington State | 0.61 | 0.55 | 0.50 |
| Solar Modules Manufactured in Washington State | 0.43 | 0.39 | 0.35 |
| Inverter Manufactured in Washington State | 0.22 | 0.2 | 0.18 |
| Any other PV System | 0.18 | 0.16 | 0.14 |

# HB 1048 / SB 5499

**STARTING DRAFT OF HB 1048 / SB 5499, THE 2017 SOLAR BILL**

- Utility customer receives the same, fixed rate for 8 years.
- Incentive rates drop each year for new (future) customers.
- Utility-specific incentive funding cap based on 2.0% of annual utility revenues, or $250k, whichever is greater.
- Early expiration of sales tax exemption in 2017.
- Balanced, well-designed incentive rate structure steps down over time:

| Fiscal Year | Residential & community solar base rate | Commercial-scale base rate | Made in WA bonus |
|---|---|---|---|
| 2018 | $0.16 / kWh | $0.06 / kWh | $0.08 / kWh |
| 2019 | $0.14 | $0.04 | $0.07 |
| 2020 | $0.12 | $0.02 | $0.07 |
| 2021 | $0.10 | $0.02 | $0.06 |

# Summary

| | Utility | SPE | Nonprofit | Foundation |
|---|---|---|---|---|
| ITC | ✔ | ✔ | | |
| MARCS Depreciation | ✔ | ✔ | | |
| WA Production Incentive | | ✔ | ✔ | |
| WA Sales Tax Exemption | ✔ | ✔ | ✔ | ✔ |
| Electricity Cost Avoidance | ✔ | ✔ | ✔ | ✔ |

# Conclusion

| Model | Total Cost | Total Benefits | NPV | Payback Period |
|---|---|---|---|---|
| SPE | $150,000 | $261,146 | $25, 627 | Year 4 |
| Non Profit | $150,000 | $176,494.5 | $-54, 034 | Year 19 |
| Foundation | $150,000 | $130,294.5 | $-95, 271 | --- |
| SPE | $128,000 | $212,427 | $1,452 | Year 10 |
| Non Profit | $128,000 | $142,191 | $-52, 589 | Year 14 |
| SPE | $150,000 | $250,528 | $26,596 | Year 5 |
| Non Profit | $150,000 | $187,755 | $-51,059 | Year 18 |
| Non Profit | $128,000 | $163,115 | $-46,759 | Year 19 |

# Recommendations

*System made in Washington with a cost of $3.75 per watt , totalling $150,000. The project will commence construction in 2018 and is projected to be fully operational before June 30, 2018. We can assume this array is not sited on state owned property.*

| Non-profit Model | 2018 | 2019 | 2020 | 2021-2044 | |
|---|---|---|---|---|---|
| WA State Production Incentive | | $24,200 | $22,000 | | |
| WA State Sales Tax Exemption | $8,887.5 | | | | |
| Cost Avoidance | | $3,758 | $3,814 | $113,835 | |
| Total | $8,887.5 | $27,958 | $25,814 | $113,835 | |
| Overall Total Benefits | | | | | $176,494.5 |
| NPV | | | | | $-54, 034 |
| Payback Period | | | | | Year 19 |

# Recommendations

*System made in Washington with a cost of $3.75 per watt, totalling $150,000. The project will commence construction in 2018 and is projected to be fully operational before June 30, 2018. We can assume this array is cited on Western's campus.*

| Foundation Model | 2018 | 2019 | 2020 | 2021-2044 | |
|---|---|---|---|---|---|
| WA State Sales Tax Exemption | $8,887.5 | | | | |
| Cost Avoidance | | $3,758 | $3,814 | $113,835 | |
| Total | $8,887.5 | $3,758 | $3,814 | $113,835 | |
| Overall Total Benefits | | | | | $130,294.5 |
| NPV | | | | | $-95, 271 |
| Payback Period | | | | | --- |

# Recommendations

*System made out of state with a cost of $3.20 per watt , totalling $128,000. The project will commence construction in 2018 and is projected to be fully operational before June 30, 2018. We can assume this array is not sited on state owned property.*

| Non-profit Model | 2018 | 2019 | 2020 | 2021-2044 | |
|---|---|---|---|---|---|
| WA State Production Incentive | | $7,040 | $6,160 | | |
| WA State Sales Tax Exemption | $7,584 | | | | |
| Cost Avoidance | | $3,758 | $3,814 | $113,835 | |
| Total | $7,584 | $10,798 | $9,974 | $113,835 | |
| Overall Total Benefits | | | | | $142,191 |
| NPV | | | | | $-52, 589 |
| Payback Period | | | | | Year 14 |

# Siting of Photovoltaic Array at WWU

Key Factors

- Year-round solar radiation availability
- Mounting
- Installation cost estimates
- Educational and aesthetic benefits

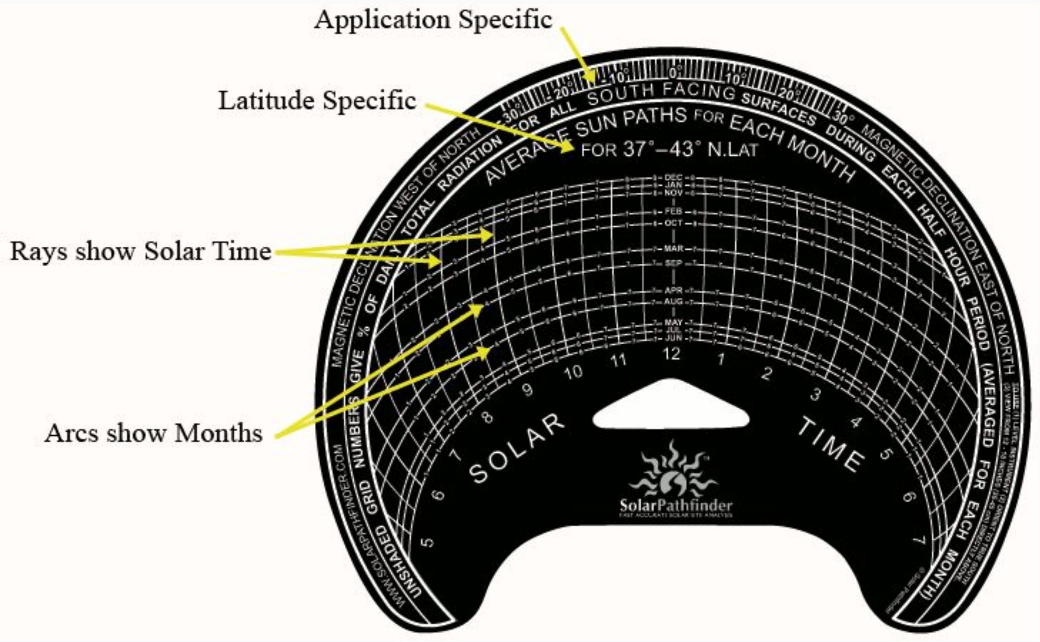
Sites Considered

- Parks Hall
- Viking Union
- Athletic Shed at Harrington Field
- Ground Mount near WK Rec Center
- Ground Mount at Grass Field S of Parking Lots

# Off-Campus Siting

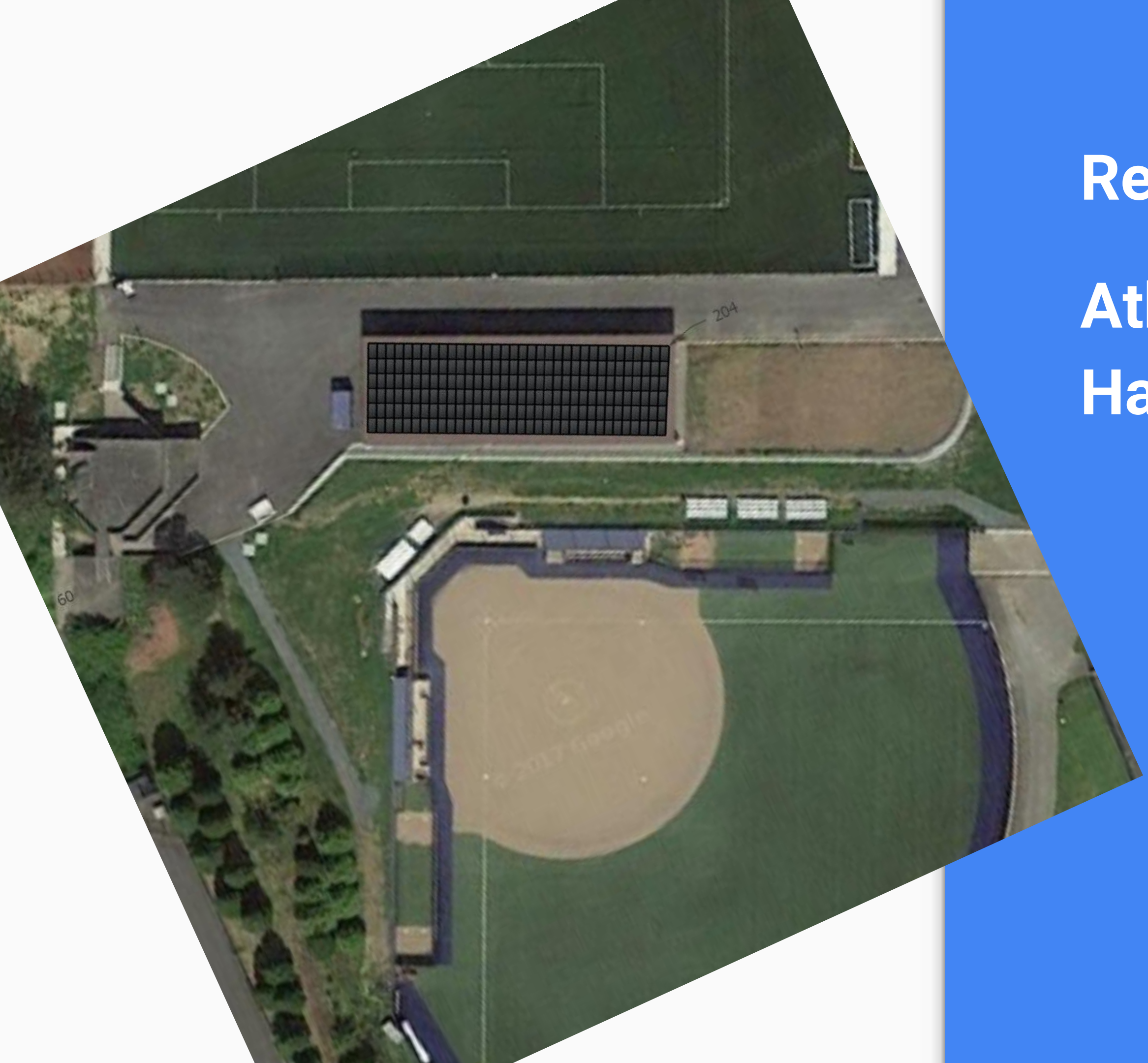
Different sites off-campus (such as the Port of Bellingham) for the project might prove to be more effective by capturing more incentives than an on-campus site could

# Solar Pathfinder Data Collection




# Solar Pathfinder Results of Assessed Sites at WWU

| | Athletics Shed | South of Parking Lot | Triangle | Parks Hall | VU |
|---|---|---|---|---|---|
| January | 86 | 87 | 88 | 97 | 90 |
| February | 90 | 87 | 82 | 94.5 | 89 |
| March | 95 | 90.5 | 90.5 | 96 | 96 |
| April | 98 | 97 | 94 | 98.75 | 97 |
| May | 99 | 99.75 | 98.5 | 98.5 | 96.25 |
| June | 98 | 98 | 97.75 | 99 | 96 |
| July | 99 | 100 | 98.5 | 100 | 97 |
| August | 98 | 97.75 | 98.75 | 98 | 96.25 |
| September | 97 | 95.5 | 93.75 | 96 | 97 |
| October | 95 | 90 | 89.5 | 96.5 | 95 |
| November | 91.5 | 88.5 | 93.5 | 98.5 | 92 |
| December | 85 | 87 | 77.5 | 96 | 90 |
| Sum | 1131.5 | 1118 | 1102.25 | 1168.75 | 1131.5 |
| **Total Percentage:** | **94.20%** | **93.17%** | **91.85%** | **97.40%** | **94.29%** |




# Recommended Site:

## Athletic Shed at Harrington Field

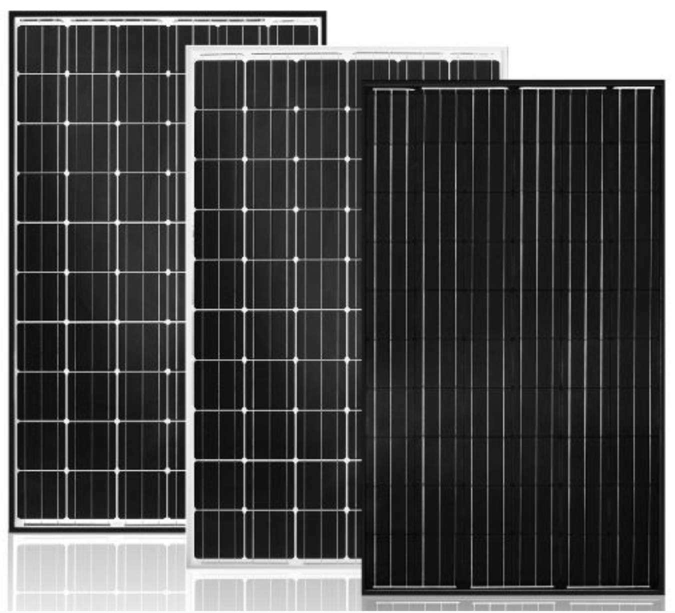
# System, Design, and Solar Data

itek ENERGY

alpha

# Solar Module Options

- Itek Energy
  - SE Module
- Alpha Technologies
  - Established relationship with WWU
- Solar Express LLC
  - Affordable for bulk buying



# Inverter Options

- String Inverter
  - Solectria
    - PVI 3800 / 5200 / 6600 / 7600 TL
  - HiQ
    - 3 Phase
- Micro Inverter
  - [e] Enphase Energy

# PV Watts Calculator

| Array Type | 34 degree tilt | 0 (horizontal) degree tilt |
|---|---|---|
| Fixed (open rack) | 42,465 kWh / yr | 36,907 kWh / yr |
| Fixed (roof mount) | 42,025 kWh / yr | 36,594 kWh / yr |
| 1-axis tracking | 50,009 kWh / yr | N/A |

# System Design

| Project Specifications | | | | |
|---|---|---|---|---|
| Module Manufacturer | Itek Energy | | Inverter | PVI 3800 TL |
| Module Model | IT 300 SE | | V max | 600 V |
| Mounting Method | Greater than 10° on flat roof | | V min | 120 V |
| Temperature Range | -10° - 38°C | | | |
| Phase | Single Phase 240 V | | | |

| Recommended String Size Solution | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pstc [W dc] | Pac [W ac] | Total Modules | Strings | Mods / Strings | VMP Hot | VOC Cold | DC – AC Ratio |
| 39,600 | 34,151 | 132 | 11 | 12 | 315 | 512 | 1.16 |

# System Design

**Field Segment 1**

Modules: 132 (39.6kWp)

Area: 429.8 m²

Description: Field Segment 1

Max Size: 40 kWp Remove

itek Energy, IT 300 HE (300W)

# System Design

**Wiring Zone**

DC | AC

DC Nameplate: 39.6KWp

AC Nameplate: 34.3KWp (1.15 DC/AC Ratio)

Description: Wiring Zone

| Inverter | Count |
|---|---|
| Solectria Renewables, PVI-380... | 9 |

Stringing

Target Range: 7 - 13 modules

# In Conclusion...

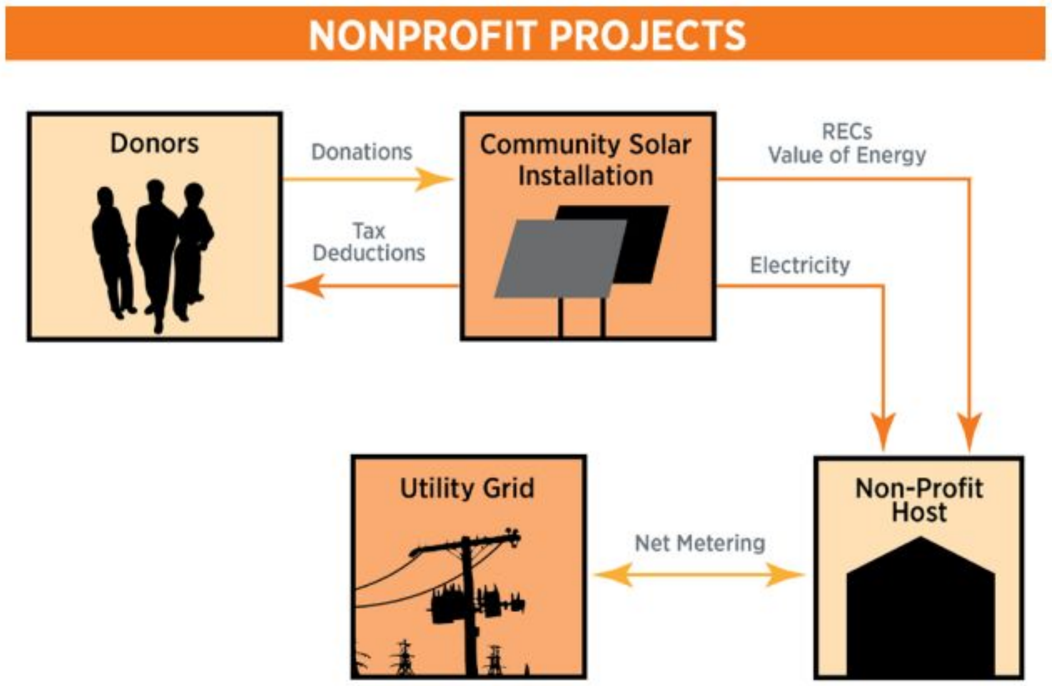
# The "Foundation Model"

WESTERN WASHINGTON UNIVERSITY FOUNDATION

The Bright Futures consulting team recommends launching a community solar project with the collaboration of the Western Washington University Foundation.

Siting solar power on Western's campus will:

- Reduce the university's electricity costs
- Will generate renewable earnings for the Foundation
- Give the WWU student body more access to renewable energy infrastructure
- Lower the university's carbon footprint
- Further professional relationships with regional energy industry



# Thank You

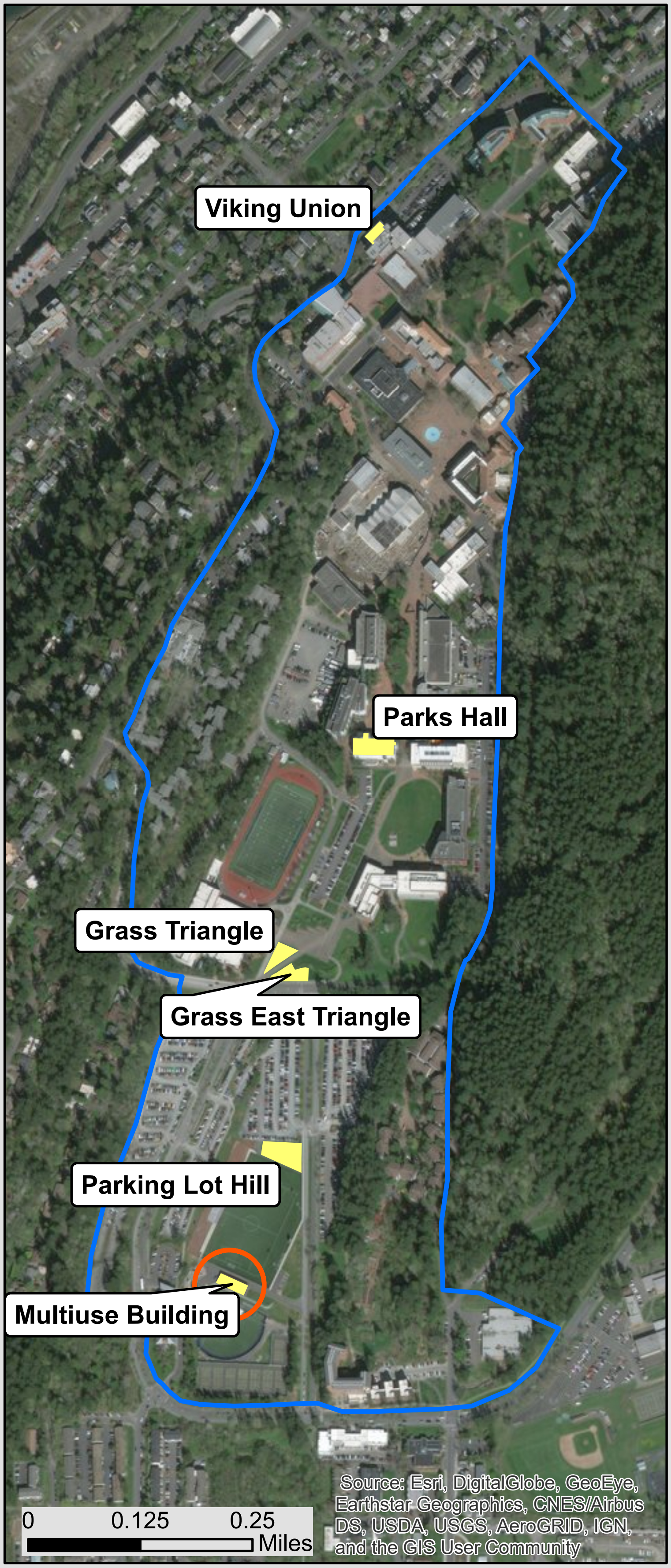
Bright Futures Consulting

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

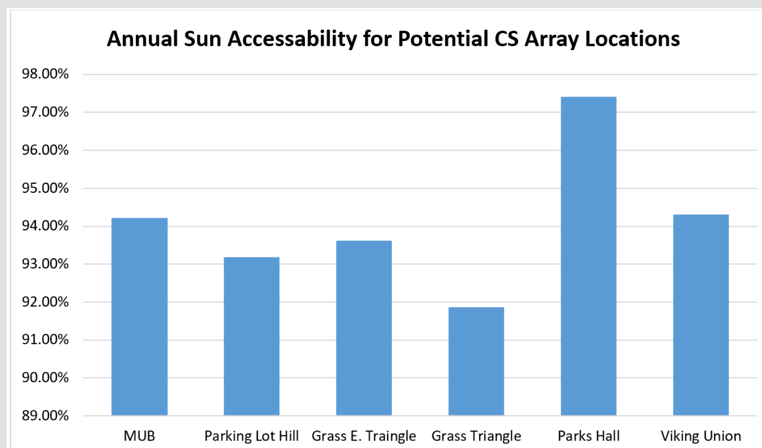
## Appendix – B

**<u>Potential Community Solar Locations At Western Washington University</u>**

# Potential Community Solar Locations at Western Washington University








## Legend

- Potential Commuty Solar Sites
- Location Chosen by ESS Course
- WWU Campus

N

Kevin Moens
Western Washington University
5/14/18

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – C

**<u>National Renewable Energy Laboratory (NREL) Technical Assistance Results</u>**





# Western Washington University - Solar PV Screening

Jesse Dean, Kosol Kiatreungwattana, and Amy Hollander

August 3rd, 2017

# Study Overview

- In support of the U.S. Department of Energy's SunShot initiative, NREL is providing Solar PV Screenings to universities seeking to go solar.

- Using the System Advisor Model (SAM) and Aurora model, NREL conducted an initial techno-economic assessment of solar PV feasibility

- NREL provides each university with customized results, including the cost-effectiveness of solar PV, recommended system size, estimated capital cost to implement the technology, and estimated life cycle cost savings.

SAM Website: https://sam.nrel.gov/
University Assistance Website: http://www.nrel.gov/technical-assistance/universities.html

# 2016 & 2017 No-cost University Technical Assistance

Projects were selected based on:

- Campus solar and sustainability goals
- Plans for future solar projects and solar deployment capacity (megawatts)
- Regional diversity
- Availability of campus energy data for the analysis

# NREL Worked with 35 Universities and Colleges

**NREL has offered no cost Implementation TA to:**

**2016**

Gallaudet University (Washington, D.C.)
Kennesaw State University (GA)
North Carolina State (NC)
Ohio University (OH)
Millersville University (PA)
Parkland College (IL)
Southern Connecticut State University (CT)
SUNY College at Oneonta (NY)
University at Albany (NY)
University of Florida (FL)

**2017**

Binghamton University (NY)
Dartmouth College (NH)
Loyola Marymount University (CA)
Loyola University (IL)
Saint Mary's College (MD)
University of Central Florida (FL)
Washington University in Saint Louis (MO)
Saint Mary's College (CA)
University of Denver (CO)
University of Illinois in Chicago (IL)
Western Washington University (WA)

**NREL has offered no cost REopt Analysis to American Universities seeking to go solar:**

**2016**

Fairleigh Dickinson University (NJ)
Lake Superior College (MN)
Luther College (IA)
Milwaukee Area Technical College (WI)
Northern Arizona University (AZ)
University of Colorado — Colorado Springs (CO)
University of Minnesota Duluth (MN)
Washington and Lee University (VA).

**2017**

Beloit College (WI)
Georgia Tech (GA)
Lane Community College (OR)
South Central College (MN)
Thomas College (ME)
Tuskegee University (AL)
University of California Riverside (CA)

# Screening Process

- Review applications
- Kick-off calls with selected universities
- Collect data for analysis
- Perform initial analysis
- Review results with client; adjust data and analysis goals if needed
- Run additional iterations to refine analysis
- Deliver final results

# Net Present Value Methodology

- Solar PV was evaluated for cost effectiveness by estimating the utility cost savings the technology could provide and comparing those savings to the estimated installation cost and annual recurring ownership costs of each

- Projects were evaluated on net present value (NPV) which includes the present value of all costs and incentives associated with each option. NPV is the present value of the savings (or costs if negative) realized by the project.

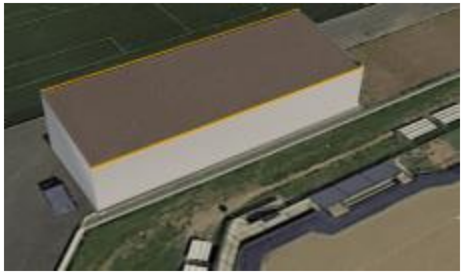
# Financing scenarios

- Systems purchased directly by the college, not eligible for tax incentives, but with a lower rate of return required
  - The college is able to benefit from lower discount rate / hurdle rate
  - The college is not able to capture tax incentives

- Systems financed through a third party eligible for federal tax incentives, but requiring a higher rate of return
  - Electricity would be sold to the college through a power purchase agreement (PPA).
  - As a tax-paying business, the financier is eligible for tax incentives that the college would otherwise not benefit from.
  - This analysis assumes the financier can fully monetize the tax incentives and they would be passed through to the college in their energy purchase contract with the developer/financier.
  - These tax incentives include the 30% investment tax credit (ITC) for solar technologies, and depreciation under the modified accelerated cost recovery system (MACRS).

# Western WA Univ. Potential Locations for PV

- NREL considered two onsite and one offsite rooftop PV system locations provided by Western WA Univ.
  - Note Athletics shed and Parks Hall are onsite and Technology Development is offsite



**Athletics Shed**


**Parks Hall**


**Technology Development**

# Washington Interconnection, Net Metering, and Incentive Policies

- Interconnection limit: 20 MW
- Net-metering limit: 100 kW
- Solar renewable energy credit (SREC) program:
  - 11 cents/kWh per year for 8 years for PV modules from WA
    - 6 cents/kWh (base rate) plus 5 cents/kWh (WA module bonus)
    - **Commercial Size:** greater than 12 kW. Annual payment capped at $25,000 per year ~ 219 kW

| Fiscal Year | Base Rate (Residential and Community Solar) (per kWh) | Base Rate (Commercial and Shared Commercial) (per kWh) | Modules Made in WA Bonus (per kWh) |
|---|---|---|---|
| 2018 | $0.16 | $0.06 | $0.05 |
| 2019 | $0.14 | $0.04 | $0.04 |
| 2020 | $0.12 | $0.02 | $0.03 |
| 2021 | $0.10 | $0.02 | $0.02 |

# Analysis Assumptions

| | Assumption |
|---|---|
| **Technologies** | Solar PV |
| **Ownership model** | Direct purchase and third party (PPA) |
| **Analysis period** | 20 years |
| **Discount rate** | 3% college/6% developer, real<br>5.06% college/8.12% developer, nominal |
| **O&M inflation rate** | 2% |
| **Utility escalation rate** | 0.93% real based on rates provided |
| **Tax incentives for developer** | PV: 30% ITC; 5 year MACRS |
| **SREC payment** | 11 cents/kWh per year for 8 years |
| **Net metering limit** | 100 kW |
| **Electricity sellback over net metering limit** | $0/kWh |
| **Interconnection limit** | 20 MW |
| **PV total installed costs** | $2.90/Watt-DC or $3.45/Watt-DC w/ WA PV panel and inverter |
| **Technology resource** | TMY3 |
| **Blended Utility Electric Rate** | $0.0959/kWh |

# Technical Potential

# Rooftop PV Design Assumptions

| Design Assumptions | |
|---|---|
| **Technologies** | Solar PV |
| **Tilt (deg)** | 10 |
| **PV Panel Size and Type** | 290 Watt SI |
| **PV Panel Efficiency** | 17.3% |
| **Inverter** | 3.8 kW / 95.7% Eff |
| **Minimum SAV for Layout** | 90.0% |
| **Row-Row Spacing** | 14 inch. |

*Solar Access Value (SAV) is calculated by Aurora and is the percentage of the time the roof is shaded at a given location. PV panels are excluded from locations with an SAV < 90%*

# System Layout

- Layouts and shading analysis done with Aurora Solar software, a commercial package
- Results are based on analyst’s best estimate of rooftop heights and tree shadings using Google Earth, Google Street View, and Bing Birds Eye
- Rooftop age, conditions, and structural integrity are not considered

# Parks Hall


## Parks Hall

- System size 75.4 kW
- PV Modules 260
- SAV 98%

# Western WA Univ. Athletics Shed

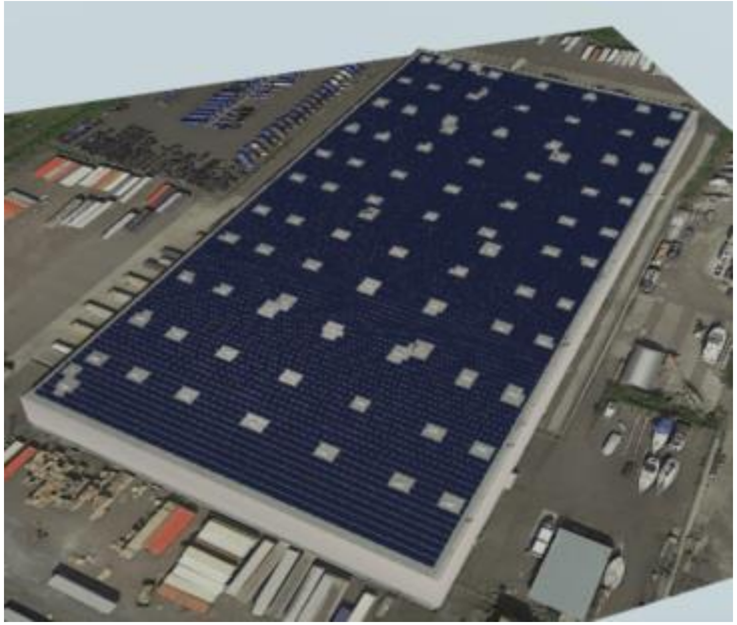
## Athletics Shed

- System size 46.4 kW
- PV Modules 160
- SAV 100%

## Athletics Shed without setback

- System size 71 kW
- PV Modules 245
- SAV 100%

# Technology Development Building




## Technology Development Building

- System size 2.9 MW
- PV Modules 10,013
- SAV 100%

# Economic Outlook

# Agency Purchase Economics

| Scenario | Athletics Shed | Parks Hall | Total |
|---|---|---|---|
| System size (kW) | 71 | 75.4 | 146.4 |
| Net capital cost ($) | $202,178 | $214,814 | $416,992 |
| Annual energy (kWh/yr) | 72,258 | 77,211 | 149,469 |
| Capacity factor (year 1) | 11.8% | 11.8% | 11.8% |
| Energy yield (year 1) | 1,036 kWh/kW | 1,036 kWh/kW | 1,036 kWh/kW |
| Levelized COE (nominal) | 20.32 ¢/kWh | 20.17 ¢/kWh | 20.25 ¢/kWh |
| Net electricity savings with system (year 1) | $6,929 | $7,404 | $14,333 |
| Net demand savings with system (year 1) | $0 | $0 | $0 |
| Net present value ($) | ($86,187) | ($90,731) | ($176,918) |
| Payback period (yrs) | 26.7 | 26.4 | 26.55 |

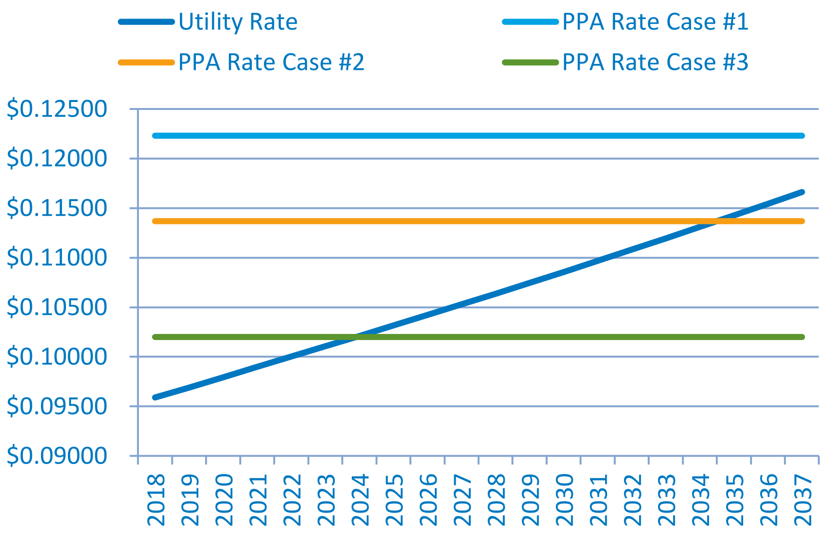
Note does not include 30% ITC or MACRS and Technology Development building was used in Community Solar Analysis

# Power Purchase Agreement Economics

- Power purchase agreement economics (20 year term)
  - Includes three scenarios
    1) With WA panels and incentives
    2) Without WA panels and incentives
    3) Without WA panels and incentives at lower cost

| Scenario | Athletics Shed with WA PV Panels (Case #1) | Athletics Shed without WA PV Panels (Case #2) | Athletics Shed without WA PV Panels at $2.09/Watt (Case #3) |
|---|---|---|---|
| System size (kW) | 46.4 | 46.4 | 46.4 |
| 1st Year PPA Rate | 12.23 ¢/kWh | 11.37 ¢/kWh | 10.02 ¢/kWh |
| NPV ($) | ($13,587) | ($7,746) | $200 |

*Note includes 30% ITC and MACRS*



# Community Solar - Case Study

1. WA panels and inverter, credit at utility rate

2. Non-WA panels and inverter, credit at utility rate

# Community Solar Model

## Key Assumptions

- Total 75 kW capacity, rooftop
- Panel leasing,
  15 panels per subscriber
- Monthly panel lease price
  - $2.75/panel/month
- 25 yr system Life
  (default for community solar)
- 6% developer discount rate
- Installed cost
  - $2.90 for WA panels & inverter
  - $2.25 for non-WA
- O&M
  - $20/kW/yr
- $0.0959/kWh utility rate

| System Owner Financials | |
|---|---|
| Business Model: | Panel Leasing |
| Monthly Panel Lease Price: | $1.75 |

| Project Information | |
|---|---|
| City: | bellington |
| State: | WA |
| System Size - DC (Gross kW): | 75 |
| Panel Size (W): | 300 |
| Installation Type: | Rooftop |
| Ownership Entity: | Non Tax-Exempt Entity |
| Panels per Subscriber: | 15 |
| Years to Full Subscription: | 1 |

### Photovoltaic System Cost Assumptions

| Construction Costs | Input Unit | Input Value (2016 USD) |
|---|---|---|
| PV Modules: | $/W | $0.90 |
| Inverters: | $/W | $0.28 |
| Racking: | $/W | $0.30 |
| Balance of System: | $/W | $0.25 |
| Engineering and Design: | $/W | $0.08 |
| Permitting and Interconnection: | $/W | $0.09 |
| Installation Labor: | $/W | $0.50 |
| Equipment Rental and Freight: | $/W | $0.05 |
| Development Overhead: | $/W | $0.45 |
| **Total Installed Cost of PV System (Ground Mount)** | **$/W** | **$2.90** |

| Site Costs | Input Unit | Input Value (2016 USD) |
|---|---|---|
| Purchase Cost of Site: | $ | $0.00 |
| Site/Land Preparation Costs: | $/W | $0.00 |
| Annual Lease Payments for Site: | $/year | $1,500.00 |
| Removal Cost: | $ | $0.00 |

| O&M Costs | Input Unit | Input Value (2016 USD) |
|---|---|---|
| Annual System Operations & Maintenance: | $/kW/year | $20.00 |

# Community Solar Model

## Key Assumptions

- 30% ITC
- REC
  - $0.21/kWh, 8 yr , WA panels & inverter
  - $0.06/kWh, 8 yr, non WA
- 35% tax rate for depreciation
- $50/hr labor rate with 2% escalation
- Annual site lease
  - $1,500 per year assumed
- O&M
  - $20/kW/yr

### Community Solar Program Assumptions

| Community Shared Solar Program | |
|---|---|
| System Life (years): | 25 |
| % of System Subscribed by Anchor Subscriber: | 40% |
| Annual Subscriber Retirement/Acquisition Rate (%): | 1.5% |
| Panel Price/Lease Escalator (%): | 0% |

| Solar Project Financial Metrics | |
|---|---|
| Annual Energy & Demand Cost Increase: | 2.00% |
| Subscriber NPV Disount Rate: | 10.00% |
| Deverloper NPV Discount Rate: | 8.00% |

### Finanacing Assumptions

| Solar Project Financing Options | | |
|---|---|---|
| | Developer | Subscriber |
| Percent of Costs Financed: | 20% | 50% |
| Interest Rate: | 6% | 8% |
| Financing Term (years): | 5 | 5 |

### Incentive Assumptions

| Incentive | Input Unit | Input Value |
|---|---|---|
| Federal Investment Tax Credit (ITC): | % of qualified costs | 30% |
| State/Local Generation Incentives, if Applicable: | $/kWh | $0.00 |
| State/Local Capacity Subsidy, if Applicable: | $/Watt | $0.00 |
| State/Local Lump Sum Incentive, if Applicable: | $ | $0.00 |
| SREC Value: | $/SREC (MWh) | $210.00 |
| SREC Lifetime: | years | 8 |
| SREC Payout Schedule: | years | 5 |
| Tax Rate for MACRs Depreciation: | % | 35% |
| Salvage Value: | % of system cost | 0.00% |

### Administrative and Transactional Cost Assumptions

| Subscriber Acquisition Assumptions | Input Unit | Input Value |
|---|---|---|
| Subscriber Acquisition Difficulty: | N/A | Moderate |
| Labor rate for Acquisition Activities: | $ | $50 |
| Labor Rate Escalator: | % | 2% |
| Upfront Billing Software Costs: | $ | $0 |
| Ongoing Billing Software Licensing Costs: | $/year | $0 |

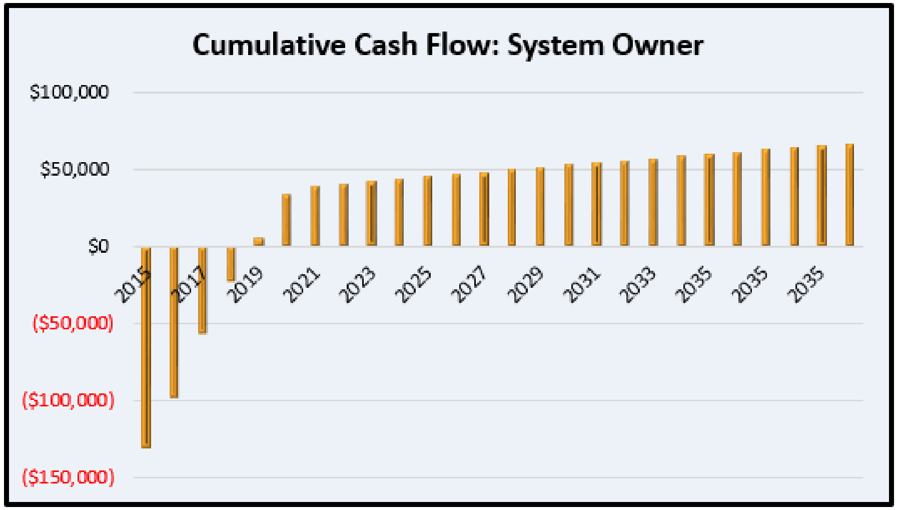
# Community Solar Results for WA Equipment

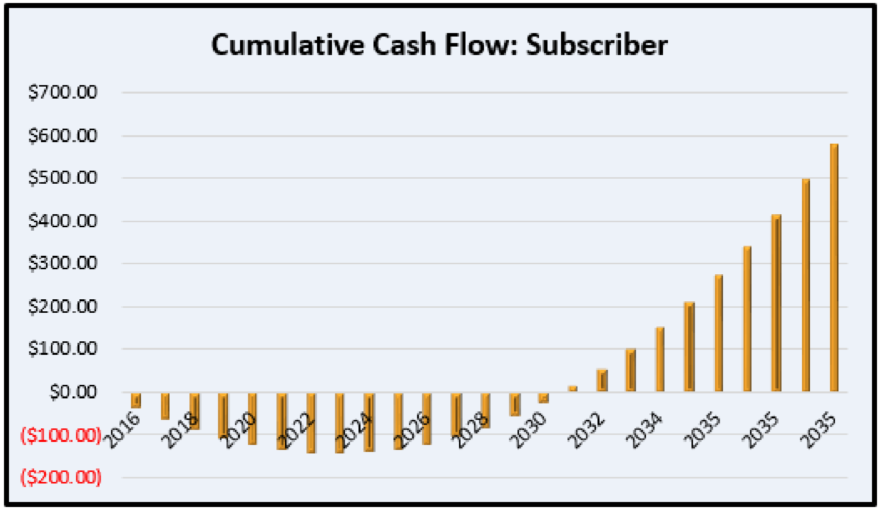
**Summary Output**

Community Solar project is **feasible**!
(Based on acceptable return on investment)

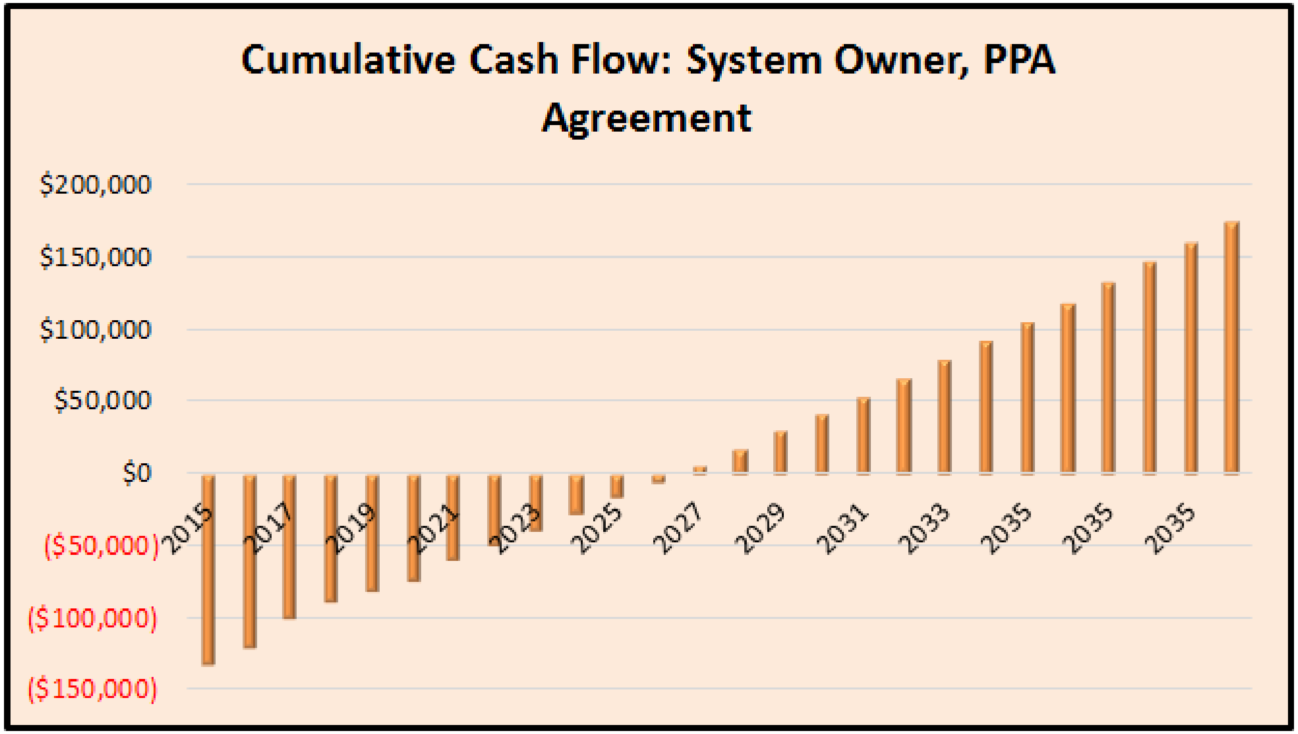
| Input/Output Summary | |
|---|---|
| System Owner IRR: | 11.5% |
| Panel Purchase Price: | N/A |
| Monthly Panel Lease Price: | $1.75 |

| Key Performace Indicator | | System Owner | Subscriber |
|---|---|---|---|
| 25-Year Costs: | $ | ($385,802) | ($7,875.00) |
| 25-Year Revenues: | $ | $452,593 | $8,456.13 |
| 25-Year Net Benefits: | $ | $66,792 | $581.13 |
| 25-Year Net Present Value (NPV): | $ | $14,604 | $12.03 |
| Return on Investment (ROI): | % | 17.3% | 7% |
| Year 1 Bill Savings: | $ | N/A | $282.40 |
| Payback Period: | years | 3.8 | 15.6 |



# Community Solar: PPA Cash Flow




*For referece: to meet the specified IRR, a system owner would need to achieve the following price per kilowatt-hour if they were to enter into a power purchase agreement with their local utility (instead of engaging in subscriber transactions):* ***$ 0.145 /kWh***

Note: PPA rate from the community solar model could be slightly higher than typical PPA due to higher administrative, acquisition, and transactional costs.

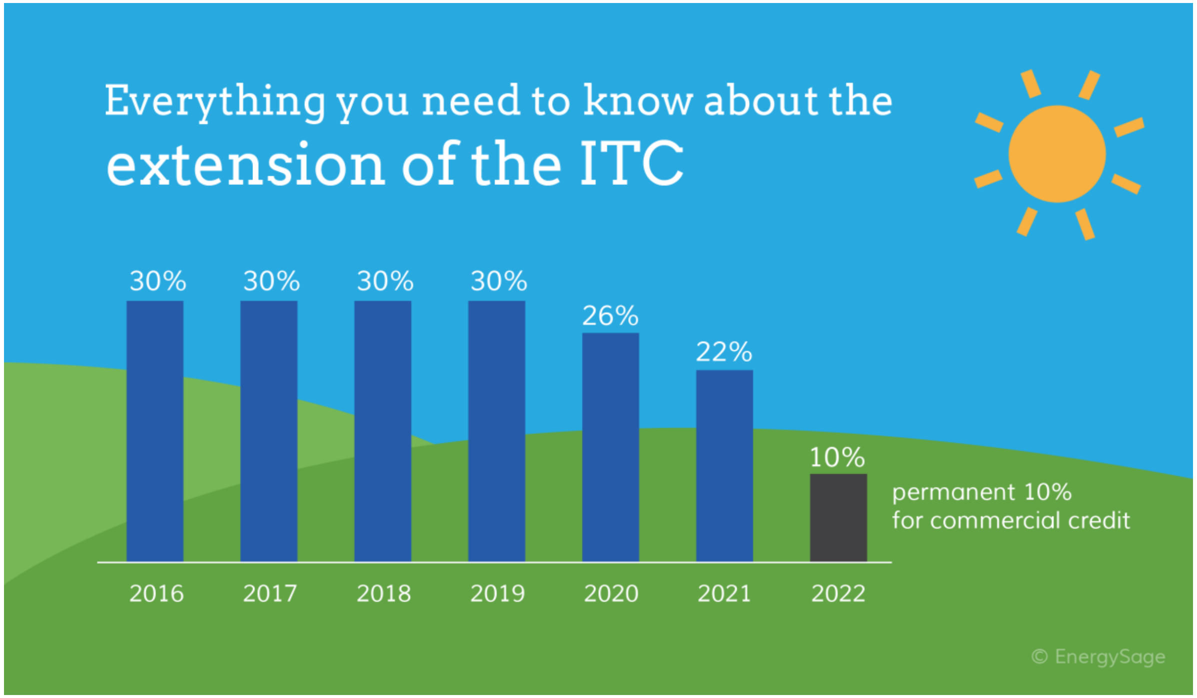
# Community Solar - Conclusions

- Community solar case is feasible for both panel leasing or PPA model.
  - Panel lease, approximately $2.75/panel/month, 15 panels per subscriber
  - PPA, $0.145/kWh
- Using WA equipment results in a better return on investment than the non-WA.
- Panel lease price may be adjusted but it will impact the economics for both owner and subscribers.
  - Higher lease price: higher owner IRR, lower subscriber IRR

| | WA equipment | Non-WA equipment |
|---|---|---|
| PV cost ($/W) | $2.90 | $2.25 |
| REC (8 years) | $0.21 | $0.06 |
| Owner IRR (%) | 16.90% | 5.40% |
| Owner payback (yr) | 3.4 yr | 11.9 yr |

# Factors Impacting Economics

- 30% ITC extended through 2019
- Future solar trade case could impose tariff on foreign PV panels and increase system costs




Reference: http://news.energysage.com/congress-extends-the-solar-tax-credit/

# Contact Information

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www.nrel.gov

NATIONAL RENEWABLE ENERGY LABORATORY

# Appendix

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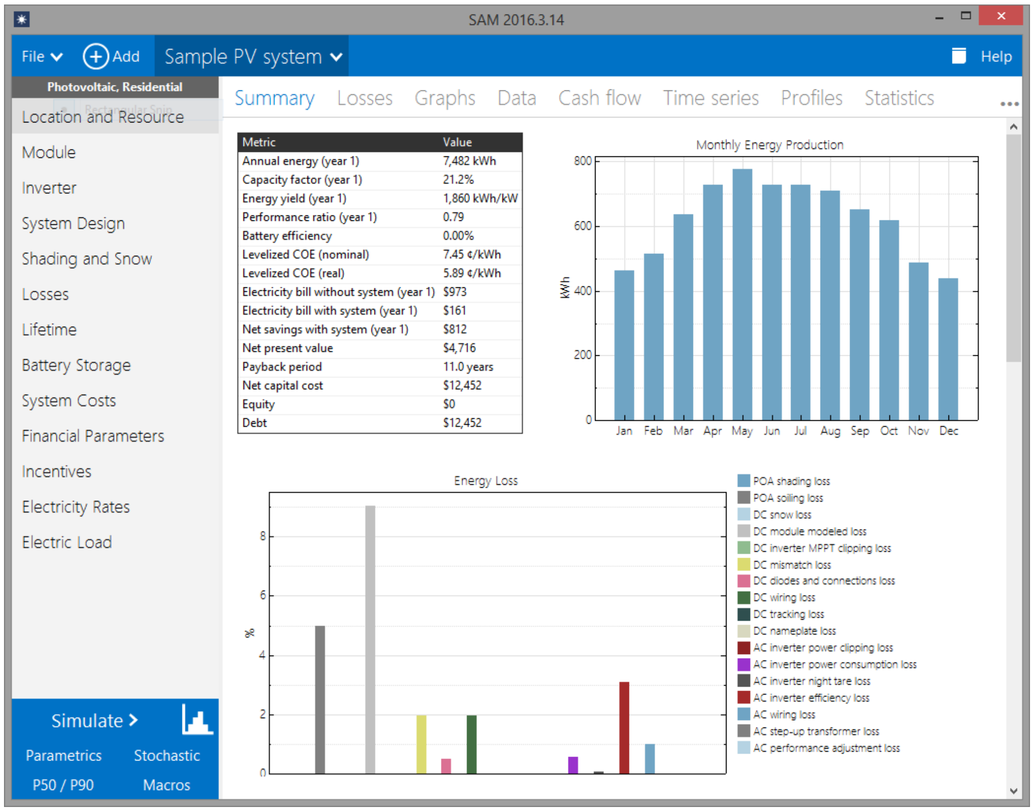
NATIONAL RENEWABLE ENERGY LABORATORY

# Modeling tools: System Advisor Model (SAM)

## Free software that combines detailed performance and financial models to estimate the cost of energy for systems




http://sam.nrel.gov/download

### Technologies

- Photovoltaics, detailed & PVWatts
- Battery storage
- Concentrating solar power
- Wind
- Geothermal
- Biomass
- Solar water heating

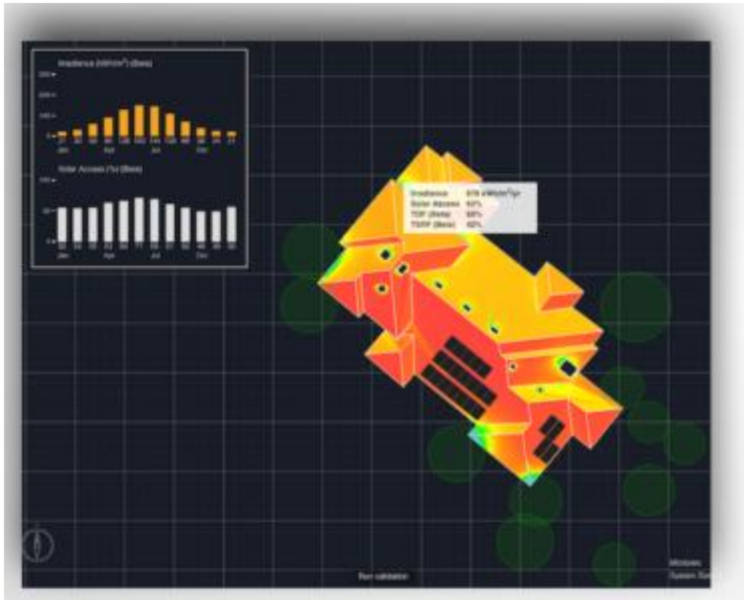
### Financials

- Behind-the-meter
  - residential
  - commercial
- Power purchase agreements
  - single owner
  - equity flips
  - sale-leaseback
- Simple LCOE calculator

# Modeling tools: Aurora

- 2D and 3D building and PV system modeling
- Detailed remote shading analysis
- Module level production simulations
- NREL validated calculation algorithms
- Used for PV panel layouts

aurora
smart solar power



# Resources

- REopt Website: http://www.nrel.gov/tech_deployment/tools_reopt.html
- SAM Website: https://sam.nrel.gov/
- University Assistance Website: http://www.nrel.gov/technical-assistance/universities.html
- NREL Brochure "Using Power Purchase Agreements for Solar Deployment at Universities" http://www.nrel.gov/docs/gen/fy16/65567.pdf
- IREC's Solar Power Purchase Agreements: A Toolkit for Local Governments (Includes an annotated model PPA)
  - http://www.irecusa.org/publications/solar-power-purchase-agreements-a-toolkit-for-local-governments/
  - Archived webinar: https://vimeo.com/125871846
- Example PPAs: Standard Commercial PPA version 1.1 (Developed by a working group of financial professionals)
  - https://financere.nrel.gov/finance/content/solar-securitization-and-solar-access-public-capital-sapc-working-group#standard_contracts
- New York K-Solar PPA Template
  - http://www.p12.nysed.gov/facplan/documents/K-SolarPPATemplatePerformanceWarrantyandPurchaserCreditAgreement.pdf
- IREC: Sample PPA (Word version)
  - http://www.irecusa.org/wp-content/uploads/2015/04/Final_Clean_PPA_Template.docx

# Analysis Disclaimer

- The analysis relies on site information provided to NREL by Western Washington University that has not been validated by NREL.
- The purpose of the screening is to inform opportunity identification of cost-effective on-site renewable energy projects. This screening should be treated as an initial step to prioritize options and focus additional, in-depth analysis of potential renewable energy projects. The results are not intended to be the basis of investment decisions.
- This analysis considers the technical and economic potential of each technology, which are two important factors in decision making. There are other factors involved in final decision-making which are not considered here, such as support of the site and surrounding community, mission compatibility, ease of permitting, and availability of funding.
- Actual project development would require more detailed assessment that could include: on-site assessments to identify appropriate project sites, including structural and land area review; verification of on-site RE resource through on-site resource measurements; identification of electrical interconnection points with sufficient capacity; confirmation of utility policies for incentives, net metering, interconnection, and buy back of excess electricity; environmental and endangered species review; and cultural and historic resources review.
- The data, results, and interpretations presented in this document have not been reviewed by technical experts outside NREL or Western Washington University.
- This analysis was conducted for internal use by Western Washington University only and is not intended for public use. The data, results, and interpretations presented in this document should not be disseminated, quoted, or cited.

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – D

## <u>Independent Study Report</u>

# Community Solar Research Study

**Analyzing the history, viability, and support of solar photovoltaics at Western Washington University**

December 11, 2017

Stella Tsitsiragos
Kellen Lynch

**Introduction and Background**

The initial phase of this project began in Spring quarter of 2017. An energy capstone class, working with an environmental studies graduate student, analyzed various approaches to community solar at Western Washington University (WWU). Through various financial assessments, site designs, and relationship building with the university administration, the class' final recommendation was to pursue a community solar model, siting a 54 kilowatt photovoltaics system on the athletics shed at WWU.

The work of the capstone class garnered the interest and support of the National Renewable Energy Laboratory, Western Solar, Washington Solar, WWU Foundation, and various administrative officials across WWU.

Since the culmination of that capstone class, students have independently continued research on the solar project. The researchers determined there was a gap in understanding the university's support of additional solar energy projects on campus. The following report addresses this gap.

Their research was conducted from September 25, 2017 to December 11, 2017. The focus of the authors' work was to determine a greater context for an additional solar energy project on WWU's campus. The authors completed this task through three chapters.

**Chapter Summary**

Chapter One analyzes the results of past solar energy projects and how they were actualized, or were not. This analysis also includes assessments of other collegiate solar energy projects across the nation.

Chapter Two illustrates the authors' results of their on-campus survey of the university community. They determined that there is overwhelming support for additional solar energy projects on the WWU campus through their survey of 203 individuals.

Chapter Three offers a final assessment and recommendation of the authors' research. Their assessment aims to balance the challenges of siting energy infrastructure on the WWU campus as well as the enthusiastic support for such initiatives.

# Chapter One

## Western Washington University
## Past Solar Energy Projects
## Case Studies

**I.** Western's Past Solar Energy Projects

**Summary**

Since 2005, select Western Washington University students, staff, and faculty have been pursuing the siting of solar arrays on the university campus. Three projects stand out as a measure of the success and challenges of implementing renewable energy at WWU. These projects have been primarily championed by students at WWU, notably Students for Renewable Energy (SRE).

Of the three solar projects, two were completed and installed. The two completed projects, both lead by SRE, took at least 2 years to complete. Beyond student support, these actualized projects required major donations from outside companies and the guidance of the WWU Foundation, administration, faculty, and staff.

The following section will outline each of the three projects, including project goals, costs, timeline, challenges, and future recommendations.

*Figure 1. Solar Array on the Viking Union Building, Western Washington Univeristy*[1]

**Viking Union Solar Demonstration Project** 2005 - 2008

<u>Project Goals</u>

"To visibly demonstrate, to students and campus visitors, the process of "green" energy production and its return to the power grid." - Students for Renewable Energy, 2008

This pilot project was carried out as a demonstration project. Small, in terms of output, this 2 kW system was intended more for educational purposes over higher power production.

[1] Source: Western Today, 2008

Output
Twelve solar modules at 170 watt each for 2000 watts of solar power.

Funding[2]
Approximately $68,000 in cash and in-kind support was secured:
$17,500 from BEF through in-kind support related to the educational kiosk
$13,000 from Alpha Energy for solar panels, racking and inverters
$15,000 in cash from PSE for construction and installation
$20,000 from WWU Foundation and the President's campus enrichment fund
$3,000 from WWU FM to cover additional structural engineering

Because this array was funded primarily through donation, the exact project cost breakdown is not available. Excluding the educational kiosk component, the project totalled about $25.5/watt which is more than 3 times the average cost of $8/watt in 2007 (NREL). The reasons for the overpriced system are likely due to engineering costs, system size, and installation costs.

Timeline[3]
Fall 2005 - Students for Renewable Energy began pursuing the solar array after successfully passing the Green Energy Fee.

2006 - Various sites were evaluated and drawings were created for review by campus administration. WWU representatives and PSE committed to working on a project for the university. Once the project was approved by WWU, the WWU Foundation met with representatives from Alpha Energy, Bonneville Environmental Fund and PSE to confirm participation. Afterwards, WWU faculty, staff and students met to develop an initial timeline and project task list.

2007 - Despite widespread enthusiasm for the project the team met challenges due to structural / aesthetic impact associated with installation.
Energy kiosk was designed and approved.

Spring 2008 - Project was completed and a dedication ceremony was planned for its launch

Total project time - about 2.5 years (including planning).

[2] Figures found in a report by SRE student project leaders, prepared by Manca Valum, Senior Director of Advancement for Strategic Initiatives.
[3] *SRE Solar Demonstration Project Report.* April 30, 2008. Prepared by Manca Valum

Challenges

Siting and designing proved difficult for this heavily supported project due to its location on the VU and the accompanying aesthetics.

Future Recommendations

"President closes with a charge to the University community to continue toward the realization of sustainability goals" - Dedication Ceremony agenda.[4] This demonstrates the recognized need for additional projects that support Western's mission of sustainability.

A lack of clear ownership has led to the disuse of the array and educational kiosk. Designating a project "owner" for succession planning for future projects will be necessary to ensure the projects are appropriately utilized throughout their full life.

Similar costs, as seen in VU Solar Project, may be unavoidable when citing future solar projects on campus, though larger projects will be more affordable through economies of scale. When working on campus, prevailing wage will lead to unavoidable increased costs, regardless of the project. Student led preliminary research and groundwork may reduce the need for additional labor and engineering costs throughout the duration of the project, avoiding unnecessarily high wage rates.

Project Leads

Nathan White, Students for Renewable Energy. Rose Woofenden, Students for Renewable Energy. Arlan Norman, Dean of CST. Tim Wynn, Director Facilities Management. Ron Bailey, Manager, Operations Support. Todd Morton, Professor Electronics Engineering.

Manca Valum, WWU Foundation. Randy Batchelor, Bonneville Environmental Foundation. Heather Mulligan, Puget Sound Energy - "Renewable Energy Education Program." Josh Miller, Alpha Energy.

[4] *SRE Solar Demonstration Project Dedication Ceremony Agenda.* Prepared by Manca Valum.

*Figure 2. Installation of the Environmental Studies Solar Array*[5]

**Environmental Studies Solar Project** 2011 - 2012

Project Goals

The goal of the solar installation was to continue the incremental adoption of on-campus solar renewable energy generation.

Output

Twenty four, 235 watt PV modules totaling 5,640 watts of solar power.

Funding[6]

5 Source: Western Today, 2012

6 *GEF Project Debrief – Environmental Studies Building Solar Array.* Page 1. Provided by Johnathan Riopelle, Sustainable Action Fund Program Advisor.

Sustainable Action Fund granted $167,500 to the solar project. The total cost of the project was $152,000.
Cost breakdown provided by the WWU Green Energy Fee (GEF) Project Debrief:

| Item | Total Cost |
|---|---|
| A&R Solar: Panels + labor | $24,500 |
| A&R Solar: Aluminum Framing + labor | $32,000 |
| A&R Solar: Other Labor & Equipment | $35,950 |
| A&R Solar: Change order | $24,000 |
| A&R Solar: State Sales tax | $4,900 |
| A&R Solar: Permitting | $700 |
| FM Trades | $850 |
| Facilities Design | $21,850 |
| Facilities Advertising and Documents | $1,625 |
| Permits | $431 |
| Geotest Services: tested bolts that hold array in place | $2,273 |
| Facilities Management 3% of expenses Project Management Fee | $3,816 |
| Sign frame | $28 |
| Copy Services production of signs | $1 |
| **Total Cost** | **$152,924** |

*Figure 3. Breakdown of costs for the Environmental Studies solar array*

According to A&R Solar records, the final amount paid to A&R Solar totaled $122,164.06. This amount, along with the additional costs of the facilities design, raised the project costs to approximately $27/watt, which is 4.5 times higher than the 2011 average of $6/watt (NREL).

The costs that were unique to this install and do not normally exist include the aluminum framing, the change order, and the engineering costs, which total around $100,000, or 60% of the cost of the project. While there were other costs to the project that were inflated due to the extra labor and equipment required for the design, these three costs will be focused on due to their substantial size and percent of total cost. The aluminum framing for the racking of the panels was a custom design requiring expensive fabrication and difficult installation. The total cost of materials and labor was $32,000, which is about 8-10 times what a standard, pre-engineered racking system would have cost. Additionally, the anchors that held the aluminum framing into the concrete walls were spec'd incorrectly requiring a change order for labor and materials of $24,000.

Timeline[7]
April 18, 2011 - GEF Grant Application Submitted to GEF Committee
May 9, 2011 - Team Awarded GEF Grant of $167,500

[7] *GEF Project Debrief – Environmental Studies Building Solar Array.* Page 1. Provided by Johnathan Riopelle.

June 2, 2011 - Work Order Request Submitted to Facilities Management
September, 30, 2011 - Final Design Signed Off
November 3, 2011 - Final Estimate Sign-Off/Bid Submission
December 12, 2011 – April 26, 2012 Construction Schedule
May, 2012 - Solar Panels Go Live
Total project time - about 2 years (including planning).

Challenges

In a letter summarizing the project, A&R Solar recommends that future projects should be done in closer collaboration with the solar installation company to utilize their expertise and avoid unrealistic siting. They state, "the special aluminum racking system is not typical in the solar industry and a more typical and cost effective approach would have been recommended by the solar installer." They continue to recommend that any future projects should be larger in size to be cost effective. In summary, A&R Solar states, "it is the opinion of A&R Solar that if WWU does another install, the cost of the project can be greatly reduced, no matter which experienced installation company is used. A&R encourages WWU to view the 5kW system that it currently has as both a learning opportunity and a high-profile project that functions as a launching pad for additional solar projects."[8]

Future Recommendations[9]

Siting: When installing future solar photovoltaic systems on Western's campus, it is recommended that the location be more thoughtfully considered. It would have been less costly if the chosen location had a flat or sloped roof that doesn't need specialized brackets for construction. The cost of the specialized aluminum framing plus labor was an additional $32,000, or 20% of the total cost.
Maintenance: Regular cleaning of the panels should be conducted in efforts to get the greatest solar output from the array. The party responsible for cleaning needs to be identified and the cleaning schedule should be implemented in the work calendar.
Size: A larger system size would be more economical due to economies of scale.
Education: It is important to follow through with the education component of the Environmental Studies building to get the most value out of the system.

Project Leads

Matthew Moroney, Project Lead, class of 2011. Hilary McGowan, Team Member, class of 2012. Elise Johnson, Team Member, class of 2014. Andy Bunn, Faculty Advisor, Huxley- Department of Environmental Sciences. Bradley Smith, Project Collaborator,

[8] A letter from Anders Hellum-Alexander, A&R Solar Sales, to the project leads.
[9] *GEF Project Debrief – Environmental Studies Building Solar Array.* Page 3. Provided by Johnathan Riopelle.

Dean of Huxley College of the Environment. Students for Renewable Energy, Project Partner

**Western SOLutions (Rejected)** 2013

Project Goals[10]
Attach a solar thermal system to supplement the Wade King Recreation Center pool, spa, and domestic hot water needs.

- Decrease Western's greenhouse gas emissions; act as a new resource to reach climate neutrality in agreement with the Western Washington University's climate action plan.
- To provide engagement and educational opportunities to WWU students interested in green technology and lowering greenhouse gas emissions.
- Learning tool for ESCI 380 and ESCI 480. "Integration into the Environmental Science class(s) will begin after construction and in the 2013-2014 school year."
- To utilize solar thermal energy to heat water for the first time on WWU's campus, broadening the usage of renewable energy technology. o Serve as a learning model for future solar thermal implementation at Western.
- Raise awareness of solar thermal energy as a tool in the Pacific Northwest Financial savings

Timeline[11]
Winter 2013

Project Leads
Students advised by Faculty in Huxley (Andy Bunn).

Funding[12]
Total projected cost: $219,511

Challenges
At this time, the challenges are unclear. From the brief Green Action Fund Project Proposal, we can infer that the project did not go through due to extremely high costs and low momentum among project leaders. In the words of past Institute for Energy Studies director, Andy Bunn, the Western SOLutions project simply " wasn't flashy enough."

[10] *Green Action Fund Project Proposal.* January 23, 2013. Page 2. Provided by Johnathan Riopelle.
[11] *Green Action Fund Project Proposal.* January 23, 2013. Page 1. Provided by Johnathan Riopelle.
[12] *Green Action Fund Project Proposal.* January 23, 2013. Page 6. Provided by Johnathan Riopelle.

## Conclusion

Using past projects as a reference for the viability of future solar installations, this investigation has shown that cost overruns, final siting, and the unique installation requirements at the university have added complications to bringing solar to WWU. These complications are most apparent when studying the Environmental Studies array which suffered greatly from its siting. The Viking Union array, while a strong example of private / public partnership, still relied heavily on donations to lead it to actualization.

It is the opinion of the authors that despite the reported complications, siting solar systems on campus ought to be pursued using the lessons learned from past installations. If WWU is to use these past project as examples in the future, this report may be a guide to learn from previous successes and mistakes to produce an optimal array, both in power production and education benefit. Our research concludes that strategic citing paired with cost consideration will be necessary in the viability of future solar projects at Western Washington University.

## II. Case Studies

**Summary**

The following section examines universities that currently utilize solar generation, both on and off campus. Each of these projects represent key elements that a community solar project at Western Washington University should take into consideration.

**American University, Washington D.C.**

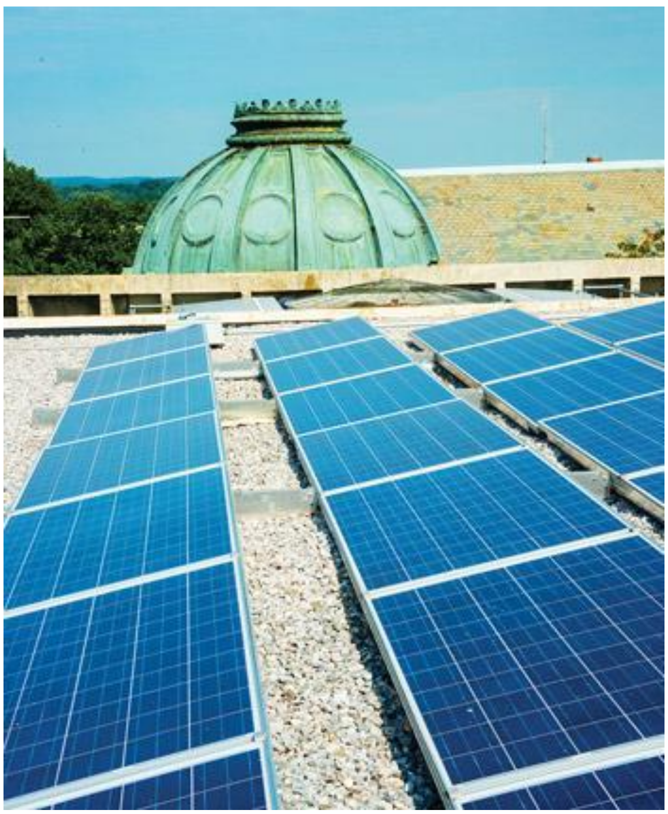


Figure 4. Solar Pannels on a campus building at American University[13]

American University uses 100% renewable energy to meet their electricity demand through a combination of on-site solar, off-site solar, and renewable energy credits. Currently, the university has 2,500 total panels installed on ten different buildings on campus. According to personal correspondence with Megan Litke, Director of

[13] Source: American University, Office of Sustainability

Sustainability Programs at American University, the initial installation of a 10 kW array on a new building, coupled with the University's climate goal of climate neutrality by 2020, sparked multiple additional solar projects. Litke stated,
“We began with just one on-site installation on a new building, then worked to implement an onsite PPA before moving to the off-site installation. We’ll see what comes next!”

An off-site project, called the Capital Partners Project, now supplies just under half of their electricity demand. This project is a renewable energy project that provides solar power to the George Washington University, American University and the George Washington University Hospital. The 52 MW system is the largest non-utility solar PV power purchase agreement in the United States (in total megawatt hours contracted).
“We have an ambitious goal of climate neutrality by 2020, these panels help get us there, and help us educate our campus community about the role solar panels can play in reducing emissions” (Litke, 2017).

Takeaway
Most of the solar electricity provided to American University is met using off-site generation, which reflects many similarities to Western Washington University.

For the past decade, Western had been committed to purchasing 100% of its electricity from green sources, through the use of renewable energy credits “RECs.” This commitment has been upheld through Western’s involvement in the new Green Direct Renewable Energy Program, which is being used to fund the construction of a new wind farm in eastern Washington. With both of these universities already receiving so much of their electricity from off-site renewable sources, the need for additional on-site, small scale investment comes into question. AU is a clear example of the ability of multiple projects to uphold a common goal.

Two universities in Michigan are operating community solar projects on their campuses. They are each a series of projects in the Consumers Energy Solar Gardens project. Both of these solar arrays demonstrate the success of installing community solar in collaboration with Universities. While the projects were primarily initated and carried out by the local public utility, Consumers Energy, the universites have had an important roll in carrying out the educational and awareness component of the arrays.

**Grand Valley State University, Allendale, MI**

*Figure 5. Community Solar Array at Grand Valley State University*[14]

The first array is located on GVSU's Allendale campus in Allendale, Michigan. The 17-acre site contains 11,200 solar panels with a rated output of about 3 MW. This project is the largest community solar project in the state of Michigan. Not only does the array have a significant environmental benefit, but it also stresses educational benefits. A team of six GVSU Engineering students built a portable, trailer-based solar panel demonstration unit in conjunction with the Solar Garden project. It serves as a working lab for hands-on student exposure and provides live data streams which students have access to. Based on

[14] Source: Consumers Energy

the solar projects, new courses on energy are currently under development in the Natural Resources Management program.

**Western Michigan University, MI**

*Figure 6. Community Solar Array at Western Mighigan University*[15]

The second array in the project is located on WMU's Kalamazoo campus at the Business, Technology and Research Park in Kalamazoo, Michigan. Approximately 3,900 solar panels were installed on 8.5 acres of land, which have a total rated output of 1 MW. The educational component of this array spans beyond just the immediate student body. According to the WMU website, the educational focus is on the community and students. They state, "Our goal is to provide information and knowledge to those who need to know about solar energy and solar power related installations, such as firefighters and other first responders, government development, zoning and regulatory individuals and organizations, and those on close or nearby contact with installations, and those interested to know more, including students, businesses, and utility customers."

Since the first project became operational in April 2016, followed shortly by the second project in August 2016, the Solar Gardens projects have produced 10,087 MWh. Any Consumers Energy electric customer, both residential and business, can subscribe to the solar project, including students.

[15] Source: Consumers Energy

Takeaway

Both of these universities stress the educational component of the solar arrays, which have been successful in increasing support for the project. Western should learn from these examples to make the educational component of the array a top priority, increasing benefit and support.

**Middleburry College, Middleburry, VT**

*Figure 7. Solar Array at Middleburry College*[16]

Middlebury College reached its goal of carbon neutrality in 2016. They accomplished this significant marker through a number of sustainable approaches, including switching to a biomass heat facility. As with most institutions, Middlebury relies primarily upon off-site generation to produce electricity, but still boasts a number of on-campus energy projects.

On-site electrical generation comes from:

- 14 kW solar system
- Two solar hot water systems
- 10 kW wind turbine.

Off-site, however, the university has invested regionally  in one 147 kW solar PV and two 500 kW solar PV systems. In 2016, 8% of Middlebury's electricity was generated through solar power.

Takeaway:

[16] Source: Middleburry College Office of Sustainability

Middlebury is a great example of a northern school that is pushing the limits of institutional solar power. From our research, it appears that Middlebury's ability to partner with solar farms, the timber industry, and regional power generators has allowed the school to achieve its ambitious goals of carbon neutrality.

**Conclusion**

Each of these collegiate energy projects demonstrate clear examples of universities utilizing solar energy in an impactful way. Similar to Western Washington University, American University relies heavily on off-site power generation, but still manages to continually add new solar arrays on campus. Western Michigan University and Grand Valley State University have successfully completed impressive community solar projects in collaboration with their local utility. Similar to Bellingham, Middlebury, VT has limited yearly sun exposure, but they have expanded and diversified their resources to reach their climate goals. Western Washington University should use these schools as a model when developing an effective solar strategy.

# <u>Chapter Two</u>

## Western Washington University
## Outreach Survey

**Surveyors**
Stella Tsitsiragos, Kellen Lynch

**Survey Goals**
Conduct an anonymous, random survey of WWU students, faculty, and staff to gauge awareness and support of energy projects on campus. Our goal was to randomly survey at least 200 people on campus representing a diverse range of majors and departments.

**Surveyor Methods**
Surveyors would randomly approach participants and state, “Hello, we are two students studying energy policy and we are conducting a survey to gather data for renewable energy projects on campus. Do you have one minute to take our survey?” Participants would privately answer the 5 question online survey on an iPad. The survey was developed using Qualtrics (see Appendix B for a copy of the survey). Respondents were only able to select one answer per question. The survey contained one manual entry question, one numeric scale question, and three multiple choice questions.

**Location**
Western Washington University - Zoe’s Bagel Shop, Wilson Library, Viking Union Cafeteria, Red Square, Artzen Building, Communications Building, Academic West Lobby, Old Main. The locations were selected based on typical high traffic areas.

**Time of day**
11 am - 3 pm, Monday - Friday
November 2nd-29th, 2017

**Survey Results**
Of the 203 people that responded, 186 were students, 11 were employees, and 6 were other. See Appendix A, Chart 1 for a breakdown of the respondents by major or department.

Of those that responded, 98% supported a 50 kW solar array on Western's athletic shed, 1% did not support the array, and 1% responded other (see Appendix A, Chart 3). Twenty eight percent said the array could be used to advance the education and engage students of Western through an interactive art display, 28% also said it could be used for class projects or labs, and 23% said it could be used as a live information display. About 9% chose that it could be used for tours, 8% for case studies, and finally, about 3% selected other (Appendix A, Chart 4).

Of campus energy projects that stand out to those surveyed, 31% selected the Environmental Science Array, about 15% selected the Viking Union Solar Array, and about 13% selected none (Appendix A, Chart 2).

**Survey Limitations**
In an attempt to reflect the opinions of a wide range of students, staff, and faculty, we chose to survey in various locations around campus; however, we were not able to survey all locations on campus which may have excluded the opinions of Western associates that do not go to the locations we chose to conduct the survey. This limited our representation. Additionally, on question three, we did not include a description for the scale. In the future we should include a description such as "0 - strongly does not impact to 5 - strongly impacts."

**Conclusions**
Overall, our survey demonstrated a wide spread support of additional solar infrastructure on the WWU campus among a variety of students, staff, and others, with 98% of the 203 surveyed in support. The highest supported uses of this array as an educational tool range from an interactive art installation, to a live information display, to class projects or labs. This reflects the diverse utilization potential for a solar array on campus, which could be incorporated into a range of curriculums.

Our results also highlight a lack of awareness regarding current solar projects on campus. The project that stood out the most to those surveyed was the Environmental Science solar array. It had a selection rate of almost 2 times more than the Viking Union array, which was selected only slightly more than "none". While the ES solar array was the top selected answer, only 31% of respondents selected it as the top energy project that stands out on campus. Additionally, question three of our survey attempted to gauge the impact of such energy projects already on campus and it appears these past projects, like the ES solar array, only have a moderate impact on the surveyee's view of WWU's sustainability.

**Future Opportunities**

While this survey produced many useful conclusions, it could be improved in the future. A future survey study might include a breakdown by age group or gender to further analyze support of such a project. Additionally, another survey could identify a larger number of participants to be more representative of the overall community. That survey should seek to include more faculty and staff respondents, as they were underrepresented in our initial analysis. This could be achieved by sending out an online survey to departments within the university.

# Chapter Three

## Western Washington University
## Our Legacy

As our student-led research team concludes this investigation into community solar at Western Washington University, we wish to be mindful of how the momentum towards campus sustainability will proceed after our report is published. The trajectory of community solar at WWU is aspirational, but its legacy is currently unclear. Our work indicates that there is overwhelming support for additional solar energy projects on campus, while simultaneously giving light to the notion that current campus energy initiatives have had only a moderate impact on the university's perceived sustainability.

Our report's findings point to an opportunity for WWU to directly address both students' education and the increasingly important issue of climate change. As our student-led team works to build a greater network among the university's staff and faculty, our progress has been hampered by the lack of precedence of such a project at WWU. However, as previously stated in this report, our community solar initiative has not been the only solar energy project launched.

Since 2007, 4 on-campus solar projects have been launched:

1. Viking Union solar demonstration project (completed)
2. Environmental Science solar array (completed)
3. Western SOLutions solar thermal project (halted)
4. WWU Community Solar (in process)

Through researching past solar energy projects at WWU, our team has noticed a re-emergent challenge present in each project. Each of these initiatives has been uniquely designed, implemented, and led by separate teams. This disparity in cohesion between the various projects, we suggest, has lead to a significant, and unnecessary amount of challenge for the project teams.

The lack of cohesion has compelled the teams to design separate approaches to solving the same fundamental goal: educate students through the installation of renewable, solar energy at WWU. Our team has observed that not only do these projects aim to serve student’s education of clean energy, but also serve Western Washington University's stated goal of addressing climate change as a leading institution of higher education. The four past solar projects give researchers a narrow base from which to build from when considering the nuances of renewable energy at the university. There are many variables for how projects are handled, and according to the survey found in Chapter Two of this report, the projects completed by teams at WWU have not caused a substantial impact on the awareness within the campus community regarding sustainability. We offer that this too is because there is a lack of consistency and intentionality among the disparate energy projects.

It is our recommendation that the WWU administration addresses the issue of climate change through direct collaboration with campus partners such as, but not limited to: Huxley College of the Environment, Facilities and Maintenance, Office of Sustainability, College of Business and Economics, and the Institute for Energy Studies.

Our team found that the university administration was often unable to answer our questions due to lack of standards and precedence when considering campus energy projects. This gap in understanding between the students and staff of WWU significantly slowed the progress of research in researching community solar at WWU. We suggest that this obstacle would be addressed if there were more precedence for these types of projects.

Our recommendations to WWU for institutionalizing these projects are:

- Encourage the administration to begin gathering a team of interested individuals from across campus to serve on the Campus Energy Projects team
- Develop a model that will work continuously over at least 6 years for the administration, the students, and the faculty leading the education
- Educate current facilities employees, or seek facilities employees who understand renewable energy systems, specifically solar installation. This may lessen project costs substantially by keeping the labor force within the university.

By creating a consistent and actionable project for WWU students, the university would have a reliable tool for teaching students the intricacies of project management and team dynamics. This type of project could create broader awareness within the administration for on-campus energy projects and would significantly address the goals of the 2017 WWU Sustainable Action Plan (SAP). In an effort to reach carbon neutrality by 2035, WWU’s SAP states, “Through structured community and campus-based co-curricular learning experiences, students gain knowledge and insight of sustainability in practice.”[1] Additionally, the plan offers this actionable advice, “In the short term, identify and implement financially viable carbon reduction projects to reduce carbon emissions by

15%, per state requirements, by 2020.”

It is the suggestion of these researchers, and the WWU Sustainable Action Plan that in order to truly meet the ambitious goals at this university, WWU must continuously engage students with projects that offers tangible use of their on-campus education, and simultaneously work to address the university’s energy impact in the face of climate change. The legacy of this Solar Research Study is now dependent upon those who have committed themselves to carrying on the work of sustainability at WWU. This research team is hopeful that this report will assist Western Washington University to further meet its goals.

## Appendix A.  Charts and Graphs

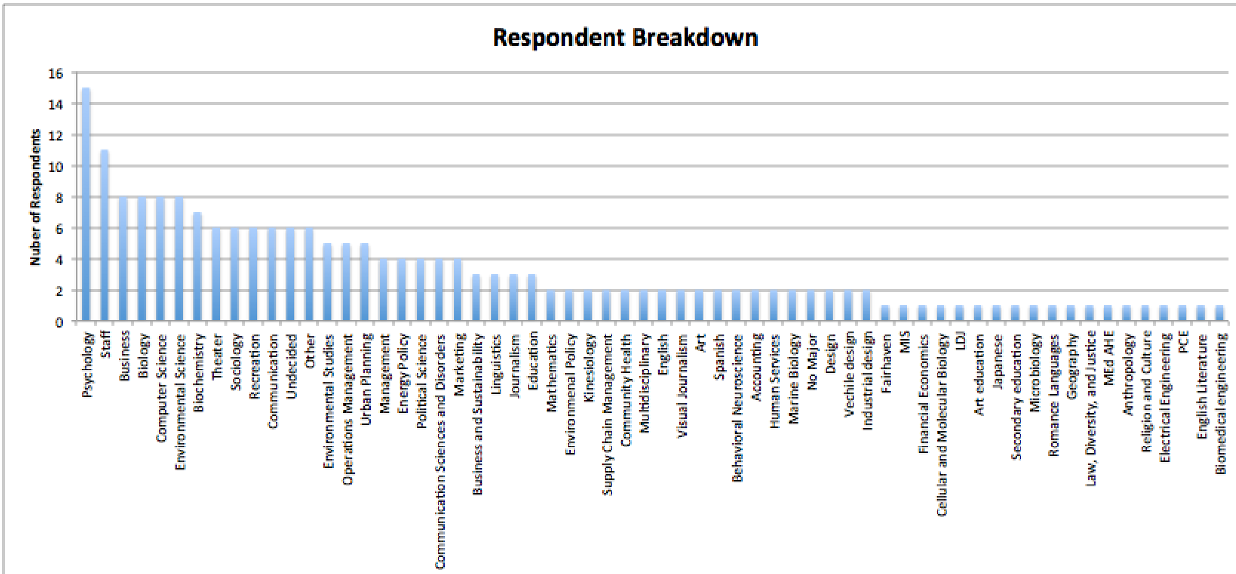



*Chart 1. Breakdown of the survey participants*

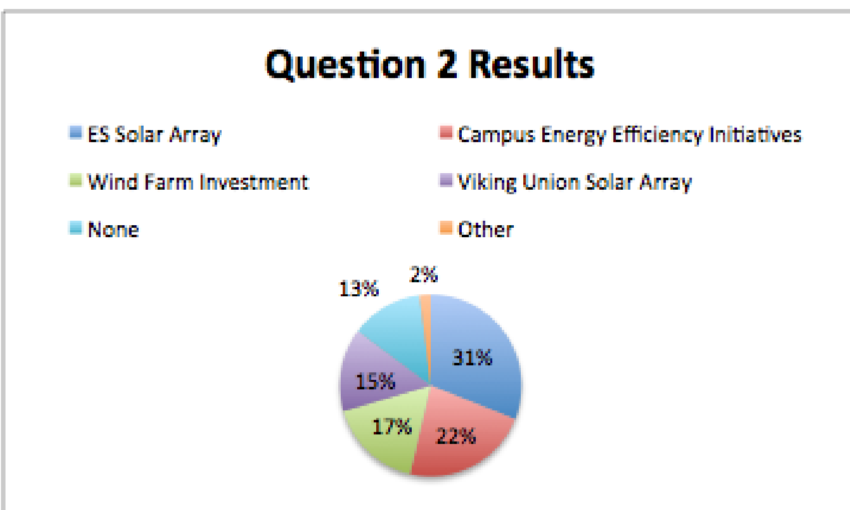



*Chart 2. Summary of responses to question 2 - Which campus energy project stands out when thinking about WWU?*

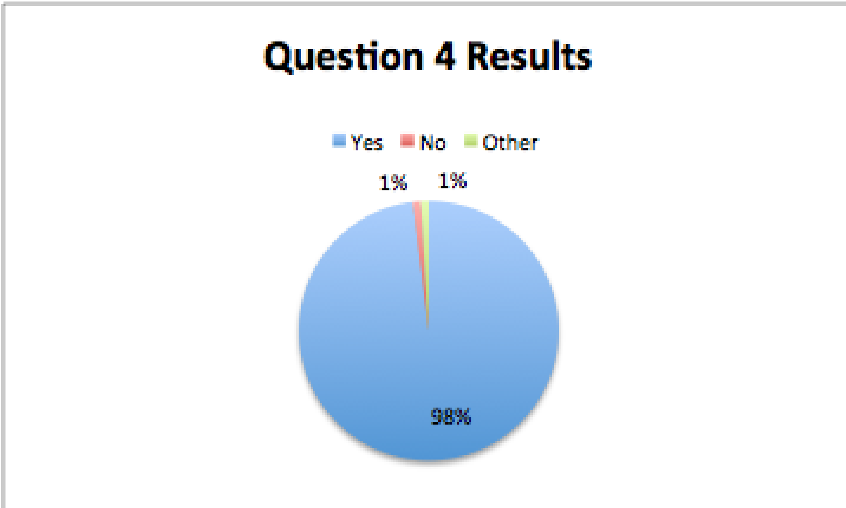



*Chart 3. Summary of responses to question 4- Would you support additional renewable energy projects on campus? For example, the addition of a 50 kW solar array on Western's athletic shed that would produce enough electricity annually to power all of Frazer Hall or the University Bookstore.*

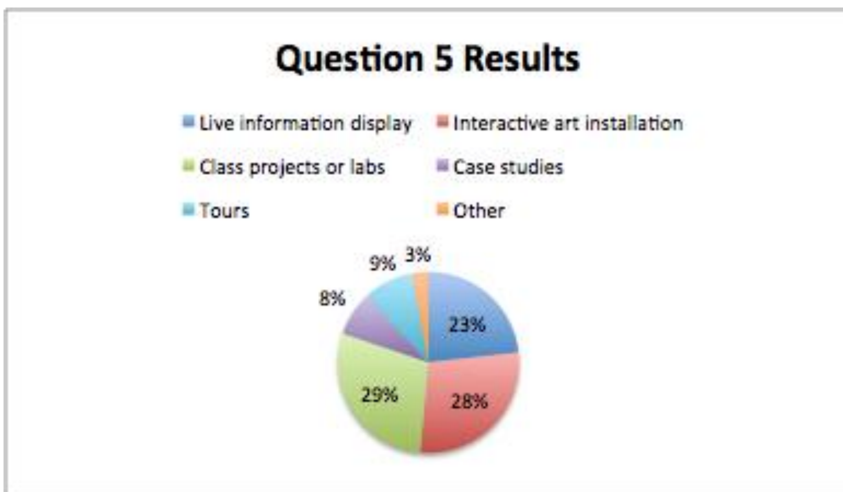
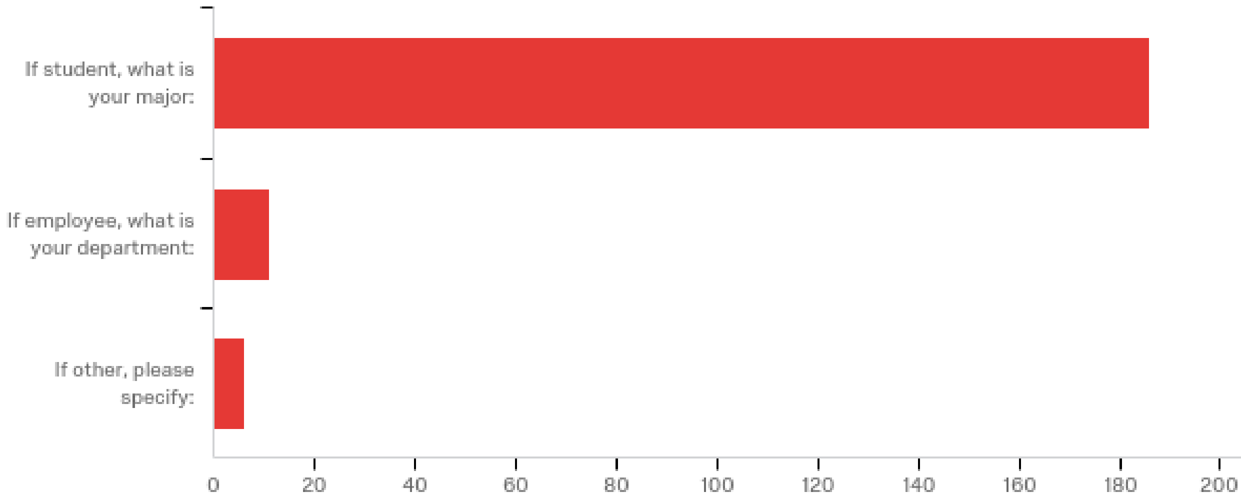



*Chart 4. Summary of responses to question 5 - How could this solar project be used to advance the education and engage the students of Western?*

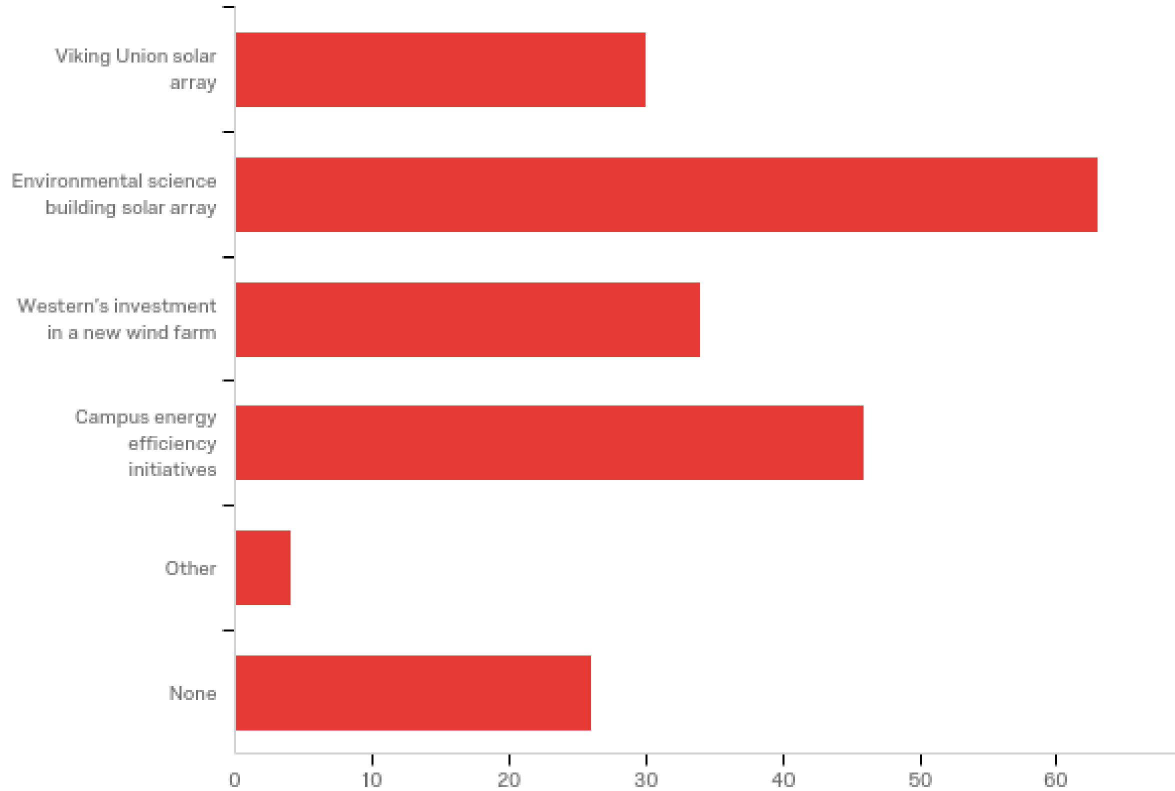
**Appendix B. Survey Results**

## Q1 - What is your role at Western?




| # | Answer | % | Count |
|---|---|---|---|
| 6 | If student, what is your major: | 91.63% | 186 |
| 7 | If employee, what is your department: | 5.42% | 11 |
| 8 | If other, please specify: | 2.96% | 6 |
| | Total | 100% | 203 |

**Q2 - Which campus energy project stands out when thinking about WWU?**




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Viking Union solar array | 14.78% | 30 |
| 2 | Environmental science building solar array | 31.03% | 63 |
| 3 | Western's investment in a new wind farm | 16.75% | 34 |
| 4 | Campus energy efficiency initiatives | 22.66% | 46 |
| 5 | Other | 1.97% | 4 |
| 6 | None | 12.81% | 26 |
| | Total | 100% | 203 |

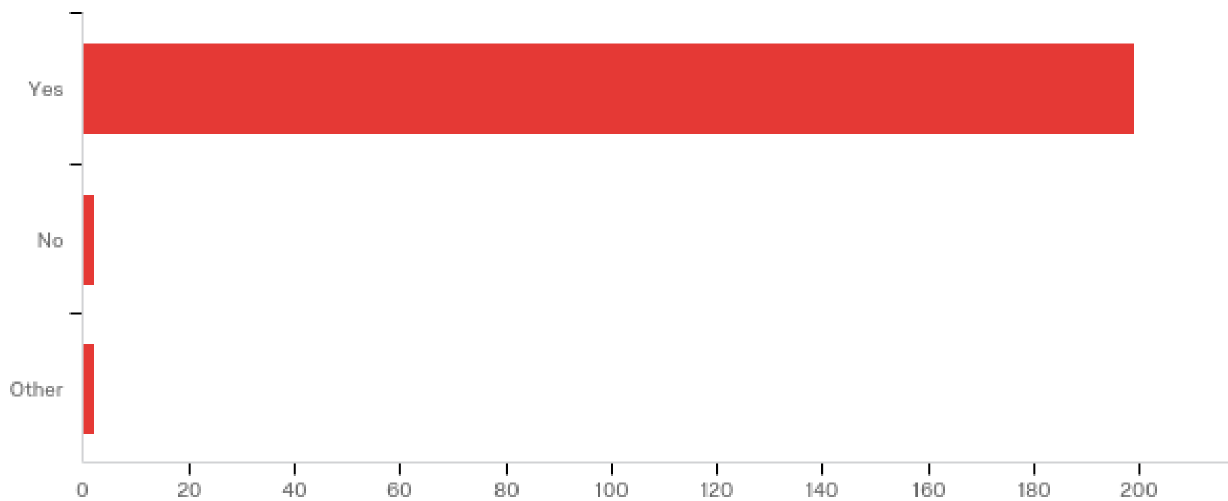
| Other - Text |
|---|
| Solar Window Project |
| Recycling |
| Waste diversion |

Solar car

**Q3 - On a scale of 0 - 5, how strongly has this project impacted your perception of Western's sustainability?**

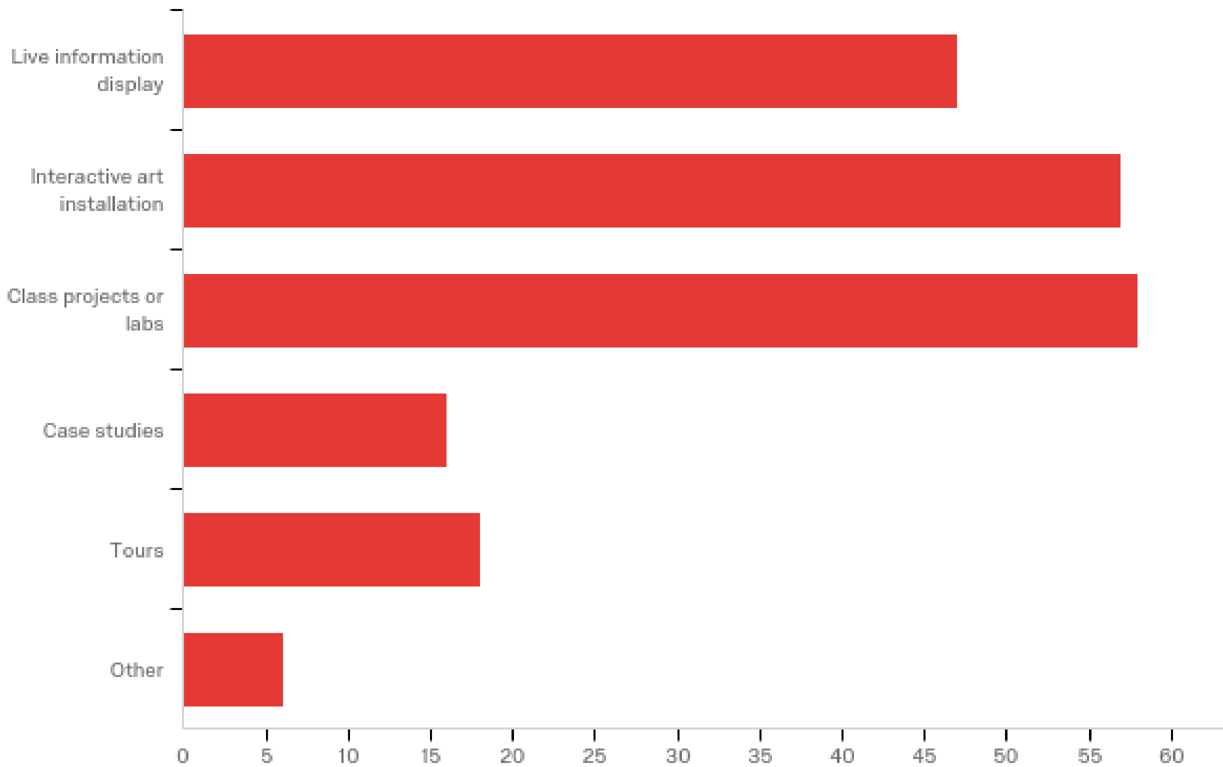
| # | Field | Minimum | Maximum | Mean | Std Deviation | Variance | Count |
|---|---|---|---|---|---|---|---|
| 1 | 0 - 5 | 0.00 | 5.00 | 2.94 | 1.31 | 1.72 | 195 |

**Q4 - Would you support additional renewable energy projects on campus? For example, the addition of a 50 kW solar array on Western's athletic shed that would produce enough electricity annually to power all of Frazer Hall or the University Bookstore.**




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Yes | 98.03% | 199 |
| 2 | No | 0.99% | 2 |
| 3 | Other | 0.99% | 2 |
| | Total | 100% | 203 |

**Q5 - How could this solar project be used to advance the education and engage the students of Western?**




| # | Answer | % | Count |
|---|---|---|---|
| 1 | Live information display | 23.27% | 47 |
| 2 | Interactive art installation | 28.22% | 57 |
| 3 | Class projects or labs | 28.71% | 58 |
| 4 | Case studies | 7.92% | 16 |
| 5 | Tours | 8.91% | 18 |
| 7 | Other | 2.97% | 6 |
| | Total | 100% | 202 |

**Appendix C. Relevant Meetings**

10/3/17 - Researchers met with the Sustainable Action Fund advisor, Johnathan Riopelle, about possible SAF funding and the ownership of the Viking Union solar demonstration project

10/10/17 - Researchers met with graduate student and project partner, Kevin Moens, to discuss project progress and campus survey.

10/17/17 - Researchers met with Beth Hartsoch of the Institutional Research Department about survey techniques when conducting research on campus.

10/17/17 - Researchers met with Seth Vidana, WWU's Campus Sustainability Manager about past renewable energy projects and the consideration of additional solar at WWU

10/19/17 - Researchers met with Manca Valum, the Senior Director of Advancement for Strategic Initiatives Senior Director of Development Corporate & Foundation Relations about the Viking Union solar demonstration project

12/2/17 - Researchers met with WWU environmental studies professor, Dr. Tammi Laninga to discuss survey results and conclusions.

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – E

**<u>Western Solar Inc. Multiuse Building Site Assessment</u>**

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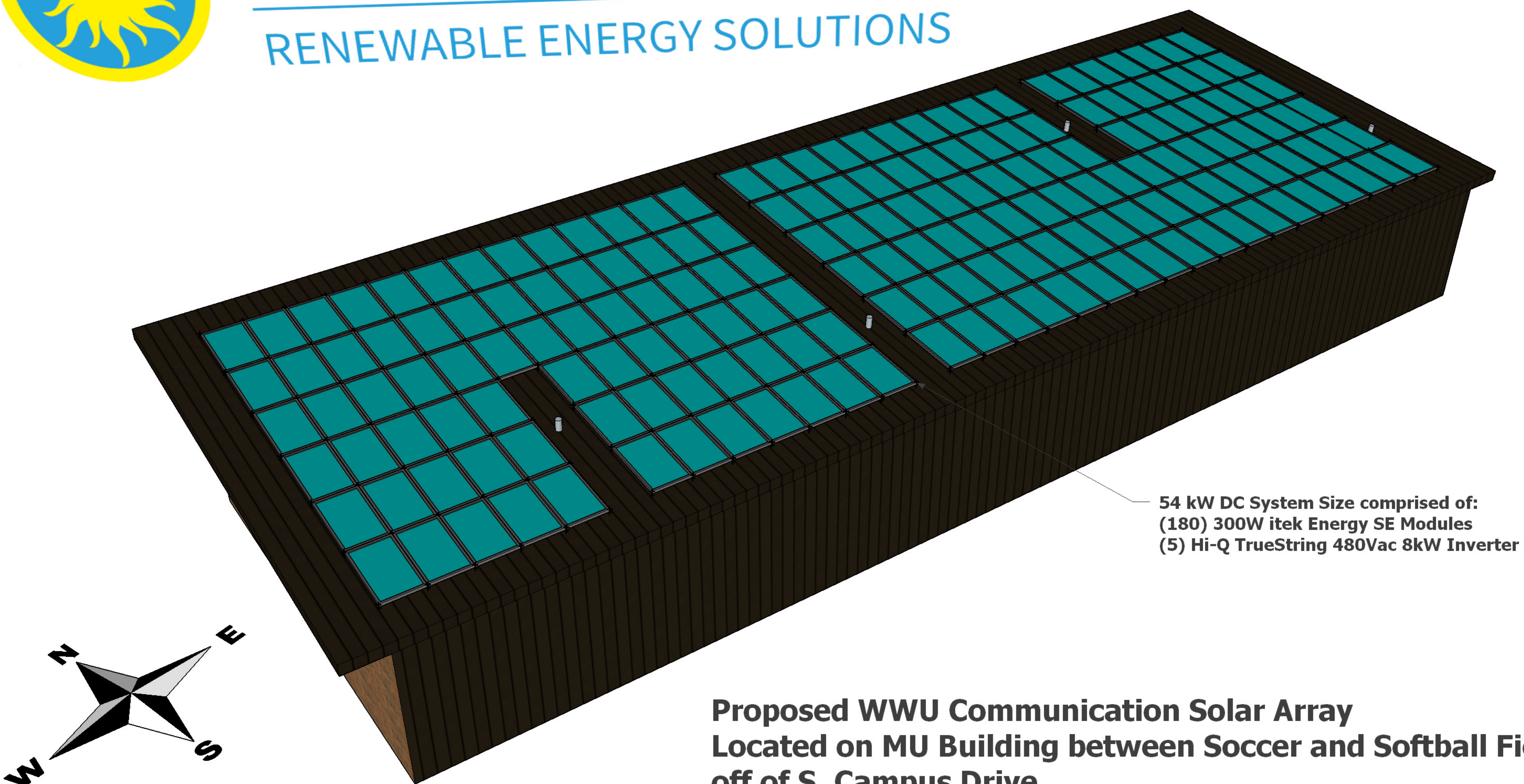



**Proposed WWU Communication Solar Array**
**Located on MU Building between Soccer and Softball Fields off of S. Campus Drive**

Western Solar
RENEWABLE ENERGY SOLUTIONS

# 25-Year Payback & Cash Flow Analysis

## Option 1 - (180) Itek Energy 300 Watt SE (TUX) Modules

54.000 kW PV Solar System using: Itek Energy Solar Panels with HiQ Compact Commercial String Inverter

WA State Production Incentive: $ 0.18 /kWh

| Payback & Cash Flow Analysis Summary | | | |
|---|---|---|---|
| Proposed System Size - Watts DC | 54,000 | Year One Savings and Incentives | $67,599 |
| Estimated Annual Production - kWhr/year | 52,430 | Net Cost at end of Year One | $109,670 |
| Installed Price per Watt/DC | $3.02 | Total WA Production Incentive | $75,499 |
| Total System Cost Installed | $163,081 | Percentage of cost recovered by Year 5 | 69.18% |
| Sales Tax | $14,188 | Internal Rate of Return (IRR) | 7.11% |

| Year | Total Installed Cost (with sales tax) | 30% Federal Income Tax Credit | Additional Utility Incentives | Annual Savings on Utility Bill* | Washington State Annual Production Rebate** | Total Annual Rebates & Energy Savings | Total Cumulative Cash Flows |
|---|---|---|---|---|---|---|---|
| 0 | ($177,269) | | | | | | ($177,269) |
| 1 | | $53,181 | $0 | $4,981 | $9,437 | $14,418 | ($109,670) |
| 2 | | | | $5,242 | $9,437 | $14,679 | ($94,991) |
| 3 | | | | $5,356 | $9,437 | $14,793 | ($80,198) |
| 4 | | | | $5,471 | $9,437 | $14,909 | ($65,289) |
| 5 | | | | $5,589 | $9,437 | $15,027 | ($50,262) |
| 6 | | | | $5,709 | $9,437 | $15,147 | ($35,115) |
| 7 | | | | $5,832 | $9,437 | $15,269 | ($19,846) |
| 8 | | | | $5,956 | $9,437 | $15,394 | ($4,452) |
| 9 | | | | $6,083 | | $6,083 | $1,631 |
| 10 | | | | $6,212 | | $6,212 | $7,842 |
| 11 | | | | $6,343 | | $6,343 | $14,186 |
| 12 | | | | $6,477 | | $6,477 | $20,662 |
| 13 | | | | $6,612 | | $6,612 | $27,274 |
| 14 | | | | $6,750 | | $6,750 | $34,025 |
| 15 | | | | $6,891 | | $6,891 | $40,916 |
| 16 | | | | $7,034 | | $7,034 | $47,949 |
| 17 | | | | $7,179 | | $7,179 | $55,128 |
| 18 | | | | $7,326 | | $7,326 | $62,455 |
| 19 | | | | $7,476 | | $7,476 | $69,931 |
| 20 | | | | $7,629 | | $7,629 | $77,559 |
| 21 | | | | $7,783 | | $7,783 | $85,343 |
| 22 | | | | $7,940 | | $7,940 | $93,283 |
| 23 | | | | $8,100 | | $8,100 | $101,383 |
| 24 | | | | $8,262 | | $8,262 | $109,645 |
| 25 | | | | $8,426 | | $8,426 | $118,072 |
| Totals | ($177,269) | $53,181 | $0 | $166,661 | $75,499 | $242,160 | $118,072 |

System Design Assumptions

*Includes projected 3.0% annual increase in utility rates and assumes site-specific production calculations.
Includes 0.8% warranted module degredation per year.
**Solar owners receive the same, fixed production incentive rate for a program term of 8 years, or until 50% of cost recouped, whichever comes first.
Payback analysis is prorated to assume our soonest available installation date.

Western Solar
RENEWABLE ENERGY SOLUTIONS

# 25-Year PSCCU Financing Cash Flow Analysis

## Option 1 - (180) Itek Energy 300 Watt SE (TUX) Modules

**54.000 kW PV Solar System using:** **Itek Energy Solar Panels with HiQ Compact Commercial String Inverter**

**WA State Production Incentive: $ 0.18 /kWh**

| PSCCU Solar Financing Analysis - Assumes Loan is Reamortized Fully After the First Year | | | |
|---|---|---|---|
| Proposed System Size - Watts DC | 54,000 | Year One Savings and Incentives | $67,599 |
| Estimated Annual Production - kWhr/year | 52,430 | Net Cost at end of Year One | $14,232 |
| Installed Price per Watt/DC | $3.02 | Total WA Production Incentive | $75,499 |
| Total System Cost Installed | $163,081 | Expected Monthly Payment - Year 1 | $1,185.96 |
| Sales Tax | $14,188 | Expected Monthly Payment - Year 2-15 | $669.23 |

| Year | Total Installed Cost (with sales tax) | 30% Federal Income Tax Credit | Financing with PSCCU at 3.75% over 15 Years | Annual Savings on Utility Bill* | Washington State Annual Production Rebate** | Total Annual Rebates & Energy Savings | Total Cumulative Cash Flows |
|---|---|---|---|---|---|---|---|
| 0 | $0 | | | | | | $0 |
| 1 | | $53,181 | -$81,830 | $4,981 | $9,437 | $14,418 | ($14,232) |
| 2 | | | -$8,031 | $5,242 | $9,437 | $14,679 | ($7,583) |
| 3 | | | -$8,031 | $5,356 | $9,437 | $14,793 | ($821) |
| 4 | | | -$8,031 | $5,471 | $9,437 | $14,909 | $6,057 |
| 5 | | | -$8,031 | $5,589 | $9,437 | $15,027 | $13,053 |
| 6 | | | -$8,031 | $5,709 | $9,437 | $15,147 | $20,170 |
| 7 | | | -$8,031 | $5,832 | $9,437 | $15,269 | $27,408 |
| 8 | | | -$8,031 | $5,956 | $9,437 | $15,394 | $34,771 |
| 9 | | | -$8,031 | $6,083 | | $6,083 | $32,823 |
| 10 | | | -$8,031 | $6,212 | | $6,212 | $31,004 |
| 11 | | | -$8,031 | $6,343 | | $6,343 | $29,317 |
| 12 | | | -$8,031 | $6,477 | | $6,477 | $27,762 |
| 13 | | | -$8,031 | $6,612 | | $6,612 | $26,344 |
| 14 | | | -$8,031 | $6,750 | | $6,750 | $25,064 |
| 15 | | | -$8,031 | $6,891 | | $6,891 | $23,924 |
| 16 | | | | $7,034 | | $7,034 | $30,957 |
| 17 | | | | $7,179 | | $7,179 | $38,136 |
| 18 | | | | $7,326 | | $7,326 | $45,463 |
| 19 | | | | $7,476 | | $7,476 | $52,939 |
| 20 | | | | $7,629 | | $7,629 | $60,567 |
| 21 | | | | $7,783 | | $7,783 | $68,351 |
| 22 | | | | $7,940 | | $7,940 | $76,291 |
| 23 | | | | $8,100 | | $8,100 | $84,391 |
| 24 | | | | $8,262 | | $8,262 | $92,653 |
| 25 | | | | $8,426 | | $8,426 | $101,080 |
| Totals | $0 | $53,181 | -$194,261 | $166,661 | $75,499 | $242,160 | $101,080 |

System Design Assumptions

*Includes projected 3.0% annual increase in utility rates and assumes site-specific production calculations.
Includes 0.8% warranted module degredation per year.
**Solar owners receive the same, fixed production incentive rate for a program term of 8 years, or until 50% of cost recouped, whichever comes first.
Payback analysis is prorated to assume our soonest available installation date.

Western Solar
RENEWABLE ENERGY SOLUTIONS

SAVING THE PLANET, ONE SOLAR PANEL AT A TIME!



# Renewable Energy System
# Quotation and Sales Contract

54.0 kW Itek Energy
Photovoltaic Grid Interface System

For:

**WWU Community Solar**
**MU Building, WWU Campus**


Prime Consultants Inc., DBA Western Solar Inc.
4041 Home Rd Ste A, Bellingham, WA 98226
Office: (360) 746-0859 • Fax: (360) 937-1407
www.westernsolarinc.com


Contractor's License #WESTES*910J0
Electrical License #WESTES*872DD
NABCEP Certified #051112-19

Western Solar
RENEWABLE ENERGY SOLUTIONS

**Renewable Energy System Quotation and Sales Contract**

**A. This agreement is between Buyer listed below and Seller (Western Solar Inc. - WSI):**

| | |
|---|---|
| Buyer Name: | WWU Community Solar |
| Contact Phone: | 0 |
| Alternate Phone: | 0 |
| Email: | 0 |
| Installation Address: | MU Building, WWU Campus |
| Mailing Address: (if different) | 0 |

**B. Project Description & Cost**

## Option1: 54.0 kW Photovoltaic System

System Size: 54,000 Watt
System Type: Roof Mounted

Western Solar offers a full turn-key Grid-tied Photovoltaic System that includes the latest:

100% Made-in-Washington high-efficiency Tuxedo (black frame-white backsheet) mono-crystalline Solar Modules from Itek Energy in Bellingham, WA

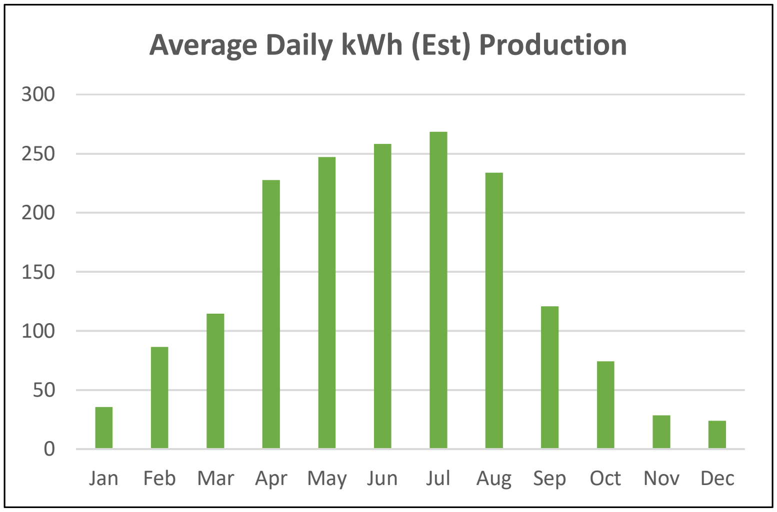
Made-in-USA Commercial 3 Phase String Inverter system from Santa Clara, CA

This system will be installed using high quality black anodized aluminum rail mounting systems from AEE Snap N'Rack that are engineered for up to 170 mph wind-speeds, and 30 lb/sqft snow loads.

Includes aluminum water-tight mounting systems for the 48" on center metal roof interconnection locations.

Each system includes all National Electric Code required disconnects, grounding/safety systems, meter bases for monitoring of the system output by the utility company, and internal (hidden when possible) conduit runs from the solar array to the inverter location. Every effort is taken to minimize the visual impact from the installed components, but the disconnect and meter locations are dictated by the National Electric Code and the local utility, requiring the installation of components adjacent to the existing primary electrical meter base.

| Estimated System Benefits | |
|---|---|
| Annual kWh Produced | 52,430 |
| Year 1 Financial Benefit | $67,598.96 |
| Percentage of cost recovered by Year 5 | 69.18% |
| Annual lbs Carbon Offset | 62,916 |
| Annual equivalent gasoline offset (gallons) | 3146 |




Western Solar's onsite, site specific Solar Pathfinder shading analysis has been combined with 30 years of weather data at your specific location to predict what your system will produce on an annual basis.

Estimated yearly benefits are calculated by combining the 30% federal tax credit, monthly reduction in utility bill through net metering, and annual production incentive payments. Production incentive payments are calculated from for 8 years following installation at the rate of $.21/kWh. Total Production incentive payments are capped at 50% of total installation cost.

All system output numbers assume average solar irradiation patterns as predicted by the National Renewable Energy Labs, semi-annual solar module cleaning by the homeowner, annual solar module degradation as expected by solar module warranties, and that the current shading patterns from trees/power-lines/etc do not change due to plant growth or the installation of new obstructions that could obscure the direct solar irradiation on the solar modules.

Western Solar always recommends reviewing potential energy efficiency measures first before installing solar, as a way to reduce the overall system cost and size that is required to off-set your annual energy loads. Please discuss this with your Western Solar sales representative if you have any questions.

**Included with this Western Solar Renewable Energy System Quotation and Sales Contract:**

**1** 180 Itek Energy 300 Watt SE, Mono-Crystalline, Tuxedo (black frame-white backsheet), Solar Modules 100% Made-in-Washington, with 25 year 80% Production Warranty and 12 Year Workmanship Warranty.

**2** 5 HiQ TS480 - 8kW rugged compact isolated commercial string inverter at 480Volt. Dual MPPT, 100% Made-in-USA. Includes 25 years of free web based monitoring and 25 year manufacturer replacement warranty. This system is compliant with all Rapid Shutdown Requirements.

**3** 1 Utility Required Solar Production Meter Base for Annual Rebate Metering. The Solar Production Meter is not included. This will be billed to the customer by the utility on the first bill after the solar production meter has been installed by the utility at a cost of $92.00 (PSE) for standard grid-tie or $425 (PSE) for grid-tie/battery back-up systems; $199 (Seattle City Light). There is no additional cost for SnoPUD customers.

**4** 1 Complete engineered Black Anodized Snap N'Rack Mounting System with anodized aluminum interconnection system connected 48" on center to existing roofing structure
Includes non-penetrating clamps for standing seam metal roof.
*Includes integrated wire-ways for hidden wiring and all stainless steel hardware*

**5** 1 NEC compliant grounding system to include: rail mounted WEEB Lugs and complete roof-mount to utility panel grounding system.

**6** Connection to Electrical Panel and Solar Net Meter per utility requirements.

**7** Turn-key installation by Western Solar's Labor and Industries Certified Electricians and Roofing Staff from start to finish, including mounting of all racking systems, inverters, conduit runs, modules, and other required solar specific equipment.

**8** All utility paperwork, system layout drawings, and electrical permitting required by the local County/City/Department of Labor & Industries and serving utility for installation and utility interconnection of the solar system.

9 All standard structural and electrical permitting required by local jurisdiction and any required third-party engineering. Engineering fees for Department of Labor and Industries plan review will be an additional charge for schools, health care facilities, and manufactured homes.

10 Western Solar is a pre-authorized contractor with Snohomish PUD, Puget Sound Energy, and Seattle City Light, automatically qualifying all systems for applicable utility rebates.

11 Electrical panel or wiring upgrades may be necessary as determined by Western Solar Electrician at the time of installation due to improperly installed electrical panels, wires, or previous non-permitted electrical work. A follow-up review by Western Solar's electrician can determine if there is a potential charge prior to contracting the system.

| | |
|---|---|
| ***Western Solar Price (Prior to all tax, credits, and incentives):*** | ***$ 163,081.00*** |
| ***Estimated Sales Tax:*** | ***$ 14,188.04*** |
| ***Turn Key System Cost (Prior to all credits and incentives):*** | ***$ 177,269.04*** |

*See attached 25 year financial analysis for details on tax credits, rebates, savings, payback time, etc.*

**Initial:** ______________

**C. Payment Terms:**

1 $1,000 non-refundable deposit due at signing of Sales Contract

2 50% of total contract amount due 6 weeks prior to installation

3 Remaining balance will be paid immediately upon final inspection and approval by the local permitting authority.

4 Additional payment terms may be available for commercial or public bid projects as negotiated prior to signing of contract

5 Quoted Price is valid for 60 days from time of quote.

**Initial:** ____________

**D. Conditions & Contingencies:**

1 WSI shall not be liable for any delay due to circumstances beyond its control including strikes, casualty, general unavailability of materials, or issuance of permits.

2 Installation schedule is estimated but not guaranteed by Western Solar and is subject to change due to, but not limited to, improper weather conditions, availability of equipment, or delay on client or client's subcontractors behalf.

3 Any disputes shall be resolved by binding arbitration in accordance with the American Arbitration Association.

4 The solar system and all components shall remain the property of seller until all work is completed and final payment is received.

5 Western Solar has presented the latest information of all incentive programs such as, Federal ITC, utility rebate programs and Washington State production payments. However, Western Solar cannot guarantee the availability and the continuation of these programs and/or payments.

**6** This contract cannot be changed without agreement by all parties involved.

**7** In the event of litigation relating to the subject matter of this agreement, the non-prevailing party shall reimburse the prevailing party for all reasonable attorney fees and costs resulting there from.

**8** If any provision of this contract is held unenforceable then such provision will be modified to reflect the parties' intention. All remaining provisions of this contract shall remain in full force and effect.

**9** If a micro-inverter monitoring system is included, Western Solar requires that the owner provide a full-time cable or wireless internet connection (not a cellular wi-fi hotspot), and a router system with at least one open interconnection location for the solar Cat-5 Networking Cable. The solar monitoring system may not detect all solar modules correctly at all times if there is in-line interference, as this system is based upon a power-line carrier signal that may encounter unforeseen system interference. Western Solar will make all attempts to ensure proper signal transfer, but this may require an additional wireless signal booster at owner's expense. String inverter monitoring systems are contracted separately.

**10** All unique permitting, fees or other required submittals beyond what pertains to standard structural and electrical permitting with local jurisdiction such as environmental impact assessments, natural resource assessments, etc are not included in the contract amount. These are typically required with ground mounts or projects near lakes/water.

**11** All ground mounted systems require trenching that will be billed at time and materials due to unknown ground conditions and obstructions between the ground mounted solar array and the interconnection location. Repair of water lines, power lines, gas lines, etc that are unknown and may be damaged during trenching will also be billed at time and materials.

**12** Contracted system is "grid-tied" only and will shut down and will not provide any backup power generation in the event of a power outage or when utility power is not provided to homeowner's electric panel, unless upgraded to battery backup system.

**Initial:____________**

**E. Warranties:**

Western Solar provides an industry leading Ten Year Warranty for our installation and interconnection services. This warranty covers replacement repair of all major wire/conduit/meter bases/sub-panels provided by Western Solar. For major system components, seller will provide buyer with copies of manufacturer's stated warranty. Western Solar will replace all inverters, racking and solar modules covered under their individual manufacturer warranties free of charge during our Ten Year period. Network connections and web-monitoring will be monitored daily free of charge for 25 years, but service calls for networking issues are covered for 12 months. Seller has estimated the energy output of the solar system and the value of incentives and paybacks as accurately as possible. However, Buyer should be aware that many factors including, but not limited to, weather, shading effects, energy consumption patterns, and different appliance loads can lead to efficiencies and power production rates either significantly more or less than those predicted. Therefore, any specific predicted energy production or consumption is not warranted. *Western Solar's warranty shall be null and void if the renewable energy system is modified, repaired or serviced by other than Western Solar or not adhered to by Western Solar's approved and suggested maintenance procedures.*

**Initial:____________**

**F. Acceptance & Authorization:**

The undersigned buyer agrees to the above terms and conditions. This quotation is valid for 60 days from date of receipt.

Payment Method

- ☐ Cash/Cashiers Check/Money Order
- ☐ Financing through PSCCU (see below)
- ☐ Other financing: ________________

| | |
|---|---|
| Date | Date |
| Customer 1 (Printed) | Western Solar Signatory Name (Printed) |
| Customer 1 (Signed) | Western Solar Signatory (Signed) |
| Customer 2 (Printed) | Western Solar Signatory Title |
| Customer 2 (Signed) | |

*Quote Prepared by Western Solar Representative*
*Markus Virta on September 21, 2017*
*360-201-2067 markus@westernsolarinc.com*

**G. Referral**

Were you referred to Western Solar by someone? If yes, please provide their name and mailing address below.

________________________________________

**H. Financing Options with PSCCU**

Western Solar recommends financing with Puget Sound Cooperative Credit Union for Solar Energy Loans. PSCCU is our lender of choice because they offer a low interest, long-term loan where the loan is secured by the solar equipment that is installed. Their financing is available up to $50,000 with no money down, no early pre-payment penalties and terms up to 240 months with rates as low as 3.5%. PSCCU's main office number is 425-283-5151 or go to www.psccu.org

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – F

**Non-profit Community Solar Financial Model**

# Non-profit Community Solar Cash Flow

| Year Count | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
| **Cash In** | | | | | |
| Incentive @ $0.18 kwh | | $ 9,437.40 | $ 9,361.90 | $ 9,287.01 | $ 9,212.71 |
| Value of Energy | | $ 4,777.27 | $ 4,739.05 | $ 4,843.96 | $ 4,949.20 |
| ITC @ 30% | | $ 53,180.71 | | | |
| Total | | $ 67,395.38 | $ 14,100.95 | $ 14,130.97 | $ 14,161.91 |
| **Cash Out** | | | | | |
| Marketing | $ 500.00 | | | | |
| Cleaning | | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| Insurance | | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 |
| Lease | | $ 12.00 | $ 12.00 | $ 12.00 | $ 12.00 |
| Administration @ $0.02/watt | | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 |
| System Costs | $ 177,269.05 | | | | |
| Production Meter | $ 92.00 | | | | |
| Inverter Replacement | | | | | |
| Total | $ 177,861.05 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 |
| **Community Solar Program Cash Flow** | | | | | |
| In | | $ 67,395.38 | $ 14,100.95 | $ 14,130.97 | $ 14,161.91 |
| Out | $ 177,861.05 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 |
| Total | $ (177,861.05) | $ 64,813.38 | $ 11,518.95 | $ 11,548.97 | $ 11,579.91 |
| Cash Position | $ (177,861.05) | $ (113,047.66) | $ (101,528.71) | $ (89,979.74) | $ (78,399.84) |

| | | | | | Community Solar Program Ends | | |
|---|---|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| | | | | | | | |
| $ 9,139.01 | $ 9,065.90 | $ 8,993.37 | $ 8,921.42 | | | | |
| $ 5,055.79 | $ 5,162.70 | $ 5,270.95 | $ 5,380.00 | $ 5,489.87 | $ 5,600.54 | $ 5,712.50 | $ 5,825.24 |
| $ 14,194.80 | $ 14,228.60 | $ 14,264.31 | $ 14,301.42 | $ 5,489.87 | $ 5,600.54 | $ 5,712.50 | $ 5,825.24 |
| | | | | | | | |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | | |
| $ 12.00 | $ 12.00 | $ 12.00 | $ 12.00 | $ 12.00 | $ 12.00 | | |
| $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | | |
| $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 500.00 | $ 500.00 |
| | | | | | | | |
| $ 14,194.80 | $ 14,228.60 | $ 14,264.31 | $ 14,301.42 | $ 5,489.87 | $ 5,600.54 | | |
| $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | $ 2,582.00 | | |
| $ 11,612.80 | $ 11,646.60 | $ 11,682.31 | $ 11,719.42 | $ 2,907.87 | $ 3,018.54 | | |
| $ (66,787.04) | $ (55,140.44) | $ (43,458.13) | $ (31,738.70) | $ (28,830.83) | $ (25,812.29) | | |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|
| 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| | | | | | | |
| $ 5,939.25 | $ 6,053.55 | $ 6,169.57 | $ 6,286.34 | $ 6,403.88 | $ 6,522.62 | $ 6,642.56 |
| $ 5,939.25 | $ 6,053.55 | $ 6,169.57 | $ 6,286.34 | $ 6,403.88 | $ 6,522.62 | $ 6,642.56 |
| | | | | | | |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| | | | $ 10,494.50 | | | |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 10,994.50 | $ 500.00 | $ 500.00 | $ 500.00 |

**WWUF Community Solar Net Benefits**

| | | |
|---|---|---|
| Costs Unrecovered | $ | (25,812.29) |
| Buy out Price | $ | 43,109.04 |
| Net Benefit | $ | 17,296.75 |

**Western Washington University Net Benefits**

| | | |
|---|---|---|
| Future Costs | $ | 17,994.50 |
| Buy out Price | $ | 43,109.04 |
| Future value | $ | 98,278.18 |
| Net Benefit | $ | 37,174.64 |

| 20<br>2038 | 21<br>2039 | 22<br>2040 | 23<br>2041 | 24<br>2042 | 25<br>2043 | **Total** |
|---|---|---|---|---|---|---|
| | | | | | | $ 73,418.71 |
| $ 6,763.69 | $ 6,885.55 | $ 7,035.38 | $ 7,188.47 | $ 7,344.89 | $ 7,504.71 | $ 149,547.52 |
| | | | | | | $ 53,180.71 |
| $ 6,763.69 | $ 6,885.55 | $ 7,035.38 | $ 7,188.47 | $ 7,344.89 | $ 7,504.71 | $ 276,146.94 |
| | | | | | | |
| | | | | | | $ 500.00 |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 12,500.00 |
| | | | | | | $ 9,900.00 |
| | | | | | | $ 120.00 |
| | | | | | | |
| | | | | | | $ 10,800.00 |
| | | | | | | $ 177,269.05 |
| | | | | | | $ 92.00 |
| | | | | | | |
| | | | | | | $ 10,494.50 |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 221,675.55 |

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – G

## <u>PvValue Report</u>

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## Income Approach Method

# Subject Property Data

### Property

| | |
|---|---|
| Address: | 516 High St |
| City: | Bellingham |
| State: | WA |
| Zip Code: | 98225 |
| Property Type: | commercial |
| PV Project Type: | existing |
| PV Ownership: | owned |

### Solar Resource

| | |
|---|---|
| System Size: | 54000 watts |
| Module Warranty Yrs: | 25 |
| System Age Yrs: | 0 |
| Remaining Yrs: | 25 |
| Derate Factor: | 0.77 |
| Degradation Rate: | 0.5 |
| Array Tilt: | 4.8 |
| Array Azimuth: | 200 |
| kWh Produced/Year: | 48,014 |

### O & M Expense

| | |
|---|---|
| Inverter Size: | 8000 watts |
| Inverter Warranty Yrs: | 15 |
| Inverter Age Yrs: | 0 |
| Inverter Replaced: | Yes |
| Replacement Cycle Yrs: | 15 |
| Replacement Cost ¢/W (survey): | 50 |
| User Replacement Cost ¢/W: | 35 |
| O & M Expense (future): | $18,900.00 |
| O & M Expense (discounted): | $10,494.50 |

### Discount Rate

| | |
|---|---|
| Discount Rate High: | 5.00 % |
| Discount Rate Avg: | 4.00 % |
| Discount Rate Low: | 3.00 % |
| FNM 30yr Rate: | 4.35 |
| FNM Date: | May 16, 2018 |
| User Input Rate (WACC): | 3% % |
| Min Basis Points: | 0 |
| Max Basis Points: | 200 |

### Estimated Value of Energy

**Low Estimated Value: $63,806.54**

**Avg Estimated Value: $71,643.07**

**High Estimated Value: $80,825.51**

### Utility Rate

| | |
|---|---|
| NREL Utility Co: | no data |
| NREL Utility Rate: | 0 ¢kWh |
| User Input Rate: | 9.1 ¢kWh |
| Utility Rate Used: | 9.1 ¢kWh |
| EIA Escalation Rate: | 2.84 %(CAGR) |
| User Input Esc Rate: | 2 %(CAGR) |
| Escalation Rate Used: | 2 %(CAGR) |

# Estimate of Accumulated Energy Production

| | | Low Estimated Value | | Avg Estimated Value | | High Estimated Value | |
|---|---|---|---|---|---|---|---|
| Year | Annual kWh | Annual Value | Accumulated Value | Annual Value | Accumulated Value | Annual Value | Accumulated Value |
| 1 | 47,774 | 4,347.43 | 4,347.43 | 4,347.43 | 4,347.43 | 4,347.43 | 4,347.43 |
| 2 | 47,534 | 4,201.99 | 8,549.42 | 4,242.40 | 8,589.82 | 4,283.59 | 8,631.01 |
| 3 | 47,294 | 4,061.32 | 12,610.74 | 4,139.80 | 12,729.62 | 4,220.57 | 12,851.59 |
| 4 | 47,054 | 3,925.26 | 16,536.00 | 4,039.58 | 16,769.20 | 4,158.38 | 17,009.97 |
| 5 | 46,814 | 3,793.65 | 20,329.65 | 3,941.68 | 20,710.88 | 4,097.00 | 21,106.96 |
| 6 | 46,574 | 3,666.36 | 23,996.01 | 3,846.05 | 24,556.93 | 4,036.41 | 25,143.38 |
| 7 | 46,334 | 3,543.25 | 27,539.26 | 3,752.65 | 28,309.58 | 3,976.62 | 29,120.00 |
| 8 | 46,093 | 3,424.18 | 30,963.44 | 3,661.41 | 31,970.99 | 3,917.61 | 33,037.61 |
| 9 | 45,853 | 3,309.02 | 34,272.46 | 3,572.29 | 35,543.28 | 3,859.37 | 36,896.98 |
| 10 | 45,613 | 3,197.65 | 37,470.11 | 3,485.25 | 39,028.53 | 3,801.89 | 40,698.87 |
| 11 | 45,373 | 3,089.94 | 40,560.05 | 3,400.24 | 42,428.77 | 3,745.16 | 44,444.03 |
| 12 | 45,133 | 2,985.77 | 43,545.82 | 3,317.20 | 45,745.98 | 3,689.18 | 48,133.21 |
| 13 | 44,893 | 2,885.04 | 46,430.86 | 3,236.11 | 48,982.09 | 3,633.93 | 51,767.13 |
| 14 | 44,653 | 2,787.62 | 49,218.48 | 3,156.90 | 52,138.99 | 3,579.40 | 55,346.54 |
| 15 | 44,413 | 2,693.41 | 51,911.89 | 3,079.55 | 55,218.53 | 3,525.59 | 58,872.13 |
| 16 | 44,173 | 2,602.32 | 44,019.71 | 3,004.00 | 47,728.03 | 3,472.49 | 51,850.12 |
| 17 | 43,933 | 2,514.23 | 46,533.94 | 2,930.22 | 50,658.25 | 3,420.09 | 55,270.21 |
| 18 | 43,693 | 2,429.04 | 48,962.98 | 2,858.16 | 53,516.41 | 3,368.38 | 58,638.59 |
| 19 | 43,453 | 2,346.68 | 51,309.66 | 2,787.80 | 56,304.20 | 3,317.35 | 61,955.94 |
| 20 | 43,213 | 2,267.04 | 53,576.70 | 2,719.08 | 59,023.28 | 3,266.99 | 65,222.93 |
| 21 | 42,973 | 2,190.03 | 55,766.73 | 2,651.97 | 61,675.25 | 3,217.30 | 68,440.22 |
| 22 | 42,732 | 2,115.57 | 57,882.30 | 2,586.44 | 64,261.70 | 3,168.26 | 71,608.49 |
| 23 | 42,492 | 2,043.58 | 59,925.88 | 2,522.45 | 66,784.15 | 3,119.88 | 74,728.36 |
| 24 | 42,252 | 1,973.98 | 61,899.85 | 2,459.97 | 69,244.11 | 3,072.13 | 77,800.49 |
| 25 | 42,012 | 1,906.68 | 63,806.54 | 2,398.95 | 71,643.07 | 3,025.02 | 80,825.51 |



* Note the community solar array buy out price is derived from the sum of the highlighted values

# Community Solar: A Pathway toward Leadership for Higher Education Institutions

## Appendix – H

## <u>For-profit Community Solar Financial Model</u>

# For-profit Community Solar Cash Flow

| Year Count | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
| **Cash In** | | | | | |
| Incentive @ $0.18 kwh | | $ 9,437.40 | $ 9,361.90 | $ 9,287.01 | $ 9,212.71 |
| Value of Energy | | $ 4,777.27 | $ 4,739.05 | $ 4,843.96 | $ 4,949.20 |
| ITC @ 30% | | $ 53,180.71 | | | |
| MARCS tax rate 30% | | $ 9,040.72 | $ 14,465.15 | $ 8,679.09 | $ 5,207.46 |
| Total | | $ 76,436.11 | $ 28,566.11 | $ 22,810.06 | $ 19,369.36 |
| **Cash Out** | | | | | |
| Marketing @$0.10/watt | $ 5,400.00 | | | | |
| Cleaning | | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| Insurance | | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 |
| Lease | | $ 450.00 | $ 450.00 | $ 450.00 | $ 450.00 |
| Administration @$0.02/watt | | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 |
| WASPI Registration | $ 450.00 | $ 350.00 | $ 350.00 | $ 350.00 | $ 350.00 |
| System Costs | $ 177,269.05 | | | | |
| Production Meter | $ 92.00 | | | | |
| Inverter Replacement | | | | | |
| Total | $ 183,211.05 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 |
| **Community Solar Program Cashflow** | | | | | |
| In | | $ 76,436.11 | $ 28,566.11 | $ 22,810.06 | $ 19,369.36 |
| Out | $ 183,211.05 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 |
| Total | $ (183,211.05) | $ 73,066.11 | $ 25,196.11 | $ 19,440.06 | $ 15,999.36 |
| Cash Position | $ (183,211.05) | $ (110,144.94) | $ (84,948.84) | $ (65,508.78) | $ (49,509.41) |

| | | | | | Community Solar Program | | |
|---|---|---|---|---|---|---|---|
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| $ 9,139.01 | $ 9,065.90 | $ 8,993.37 | $ 8,921.42 | | | | |
| $ 5,055.79 | $ 5,162.70 | $ 5,270.95 | $ 5,380.00 | $ 5,489.87 | $ 5,600.54 | $ 5,712.50 | $ 5,825.24 |
| $ 5,207.46 | $ 2,603.73 | | | | | | |
| $ 19,402.25 | $ 16,832.33 | $ 14,264.31 | $ 14,301.42 | $ 5,489.87 | $ 5,600.54 | $ 5,712.50 | $ 5,825.24 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | $ 990.00 | | |
| $ 450.00 | $ 450.00 | $ 450.00 | $ 450.00 | $ 450.00 | $ 450.00 | | |
| $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | $ 1,080.00 | | |
| $ 350.00 | $ 350.00 | $ 350.00 | $ 350.00 | $ 350.00 | $ 350.00 | | |
| $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 500.00 | $ 500.00 |

| | | | | | |
|---|---|---|---|---|---|
| $ 19,402.25 | $ 16,832.33 | $ 14,264.31 | $ 14,301.42 | $ 5,489.87 | $ 5,600.54 |
| $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 | $ 3,370.00 |
| $ 16,032.25 | $ 13,462.33 | $ 10,894.31 | $ 10,931.42 | $ 2,119.87 | $ 2,230.54 |
| $ (33,477.16) | $ (20,014.83) | $ (9,120.52) | $ 1,810.91 | $ 3,930.78 | $ 6,161.32 |

| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|
| 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 |
| | | | | | | | |
| $ 5,939.25 | $ 6,053.55 | $ 6,169.57 | $ 6,286.34 | $ 6,403.88 | $ 6,522.62 | $ 6,642.56 | $ 6,763.69 |
| $ 5,939.25 | $ 6,053.55 | $ 6,169.57 | $ 6,286.34 | $ 6,403.88 | $ 6,522.62 | $ 6,642.56 | $ 6,763.69 |
| | | | | | | | |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |
| | | | $ 10,494.50 | | | | |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 10,994.50 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 |

**Community Solar Company Net Benefit**

| | | |
|---|---|---|
| Cash Position | $ | 6,161.32 |
| Buy out Price | $ | 43,109.04 |
| Net Benefit | $ | 49,270.36 |

**Western Washington Univeristy Net Benefits**

| | | |
|---|---|---|
| Future Costs | $ | 17,994.50 |
| Buy out Price | $ | 43,109.04 |
| Future value | $ | 98,278.18 |
| Net Benefit | $ | 37,174.64 |

| 21<br>2039 | 22<br>2040 | 23<br>2041 | 24<br>2042 | 25<br>2043 | Total |
|---|---|---|---|---|---|
| | | | | | $ 73,418.71 |
| $ 6,885.55 | $ 7,035.38 | $ 7,188.47 | $ 7,344.89 | $ 7,504.71 | $ 149,547.52 |
| | | | | | $ 53,180.71 |
| | | | | | |
| $ 6,885.55 | $ 7,035.38 | $ 7,188.47 | $ 7,344.89 | $ 7,504.71 | $ 276,146.94 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | $ 5,400.00 |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 12,500.00 |
| | | | | | $ 9,900.00 |
| | | | | | $ 4,500.00 |
| | | | | | |
| | | | | | $ 10,800.00 |
| | | | | | $ 3,950.00 |
| | | | | | $ 177,269.05 |
| | | | | | $ 92.00 |
| | | | | | $ 10,494.50 |
| $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 234,905.55 |